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The Practical Teacher

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Wisdom is humble that he knows no more.'—COWPER.

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ARITHMETIC PRIZE PAPERS.

BY W. P. WORKMAN, M.A., B.SC.,

Head Master of Kingswood School; late Fellow of Trinity College, Cambridge.

[Arithmetic Prize Paper, No. III., will appear in our next number.]

ARITHMETIC PRIZE PAPER, NO. II.—SOLUTIONS.

1. (1) The connection of the numbers involved in this question with well-known circulating decimals will be immediately perceived. This can be used for the evaluation of the fractions thus :—

$$\cdot 234\dot{3} = \cdot 234,\dot{3}33,333,333,333,\dot{3}3\dot{3} = \frac{234,333,333,333,099}{999,999,999,999,000},$$

$$\text{so } \cdot 456142857\dot{1} = \cdot 456,142,857,142,857\dot{1} = \frac{456,142,857,142,401}{999,999,999,999,000}.$$

Hence the given fraction

$$= \frac{\cdot 234\dot{3}}{\cdot 456142857\dot{1}} = \frac{234\frac{1}{3}}{456\frac{1}{7}} = \frac{4921}{9579}. \quad \text{Ans.}$$

(2) In a similar manner it follows that the second fraction

$$= \frac{234\frac{1}{7}}{345\frac{1}{13}} = \frac{1639 \times 13}{4486 \times 7} = \frac{21307}{31402}.$$

2. A runs the 100 yards which he has to run in 10″·000.

B ,, 98 ,, ,, ,, ,, $98 \times \frac{10\frac{1}{6}}{100} = 9''\cdot 996.$

C ,, 96 ,, ,, ,, ,, $96 \times \frac{10\frac{2}{6}}{100} = 9''\cdot 984.$

D ,, 94 ,, ,, ,, ,, $94 \times \frac{10\frac{3}{6}}{100} = 9''\cdot 964.$

Hence they reach the finish in the order D, C, B, A.

In 9″·964 A has run 99·64 yards, for he runs 10 yards per second, ∴ he is ·36 yards, = 1 ft. 0·96 in., away from D when D finishes.

3. Since the number 1053924187 is the product of three factors, the difference of the greatest and least of which is 8, it is obvious that these three factors must be prime numbers, and that the middle one of the three cannot differ much from the cube root of the number.

The cube root is 1017.....

The factors must, therefore, be primes in the neighbourhood of 1017. By trial it is found at once that they are

$$1013 \times 1019 \times 1021.$$

4. A certain interval in hour spaces separates the two hands. Between the two incidents the hour hand has moved through this interval.

Therefore the minute hand has moved through 12 times the interval. It is now in the position between IV and V. If it were moved on through this interval it would coincide with its former position, and would have revolved just three times completely round, *i.e.*, through 36 hour spaces. But it would now have traversed the interval 13 times.

∴ the interval is $\frac{36}{13}$ hour spaces.

Now at 4.30 the hands are $1\frac{1}{2}$ hour spaces apart. They increase their distance apart by 11 hour spaces every hour.

∴ they increase their distance by 1 hour space in $\frac{1}{11}$ hour;

∴ ,, ,, ,, ,, ,, $(\frac{36}{13} - 1\frac{1}{2})$ hour space in $\frac{1}{11}(\frac{36}{13} - \frac{3}{2})$ hours.

∴ they are $\frac{36}{13}$ hour spaces apart $\frac{1}{11} \cdot \frac{33}{26} = \frac{3}{26}$ hours after 4.30, *i.e.*, at

4 h. 36 m. $55\frac{5}{13}$ s.

[This problem is essentially the same as the Ambiguous Clock problem in the last paper.]

5. The integer in question must be the integer nearest to $\frac{1}{\cdot 0001025536}$, which = 9750·998502329..... Hence it is 9751.

The question, therefore, amounts to this :—

1. At what decimal place does $\sqrt{9751}$ differ from $\sqrt{\frac{1}{\cdot 0001025536}}$

2. ,, ,, ,, ,, $\sqrt[3]{9751}$,, $\sqrt[3]{\frac{1}{\cdot 0001025536}}$

Now 1st, $\sqrt{9751} - \sqrt{9750\cdot 9985...}$

$$= \sqrt{9751} - \sqrt{9751 - \cdot 0015.....}$$

$$= \sqrt{9751}\left\{1 - \left(1 - \frac{\cdot 0015...}{9751}\right)^{\frac{1}{2}}\right\}$$

$$= \sqrt{9751}\left\{1 - \left(1 - \frac{1}{2} \cdot \frac{\cdot 0015...}{9751} - .....\right)\right\}$$

$$= \frac{1}{2} \cdot \frac{\cdot 0015...}{\sqrt{9751}} + \text{much smaller terms}$$

$$= \frac{\cdot 0007...}{\sqrt{9751}} + ...$$

$$= \cdot 000007.....$$

The information is not therefore relevant until the 6th place of decimals.

Secondly, $\sqrt[3]{9751} - \sqrt[3]{9750\cdot 9985}$

$$= \text{similarly } \sqrt[3]{9751}\left\{1 - \left(1 - \tfrac{1}{3} \cdot \frac{\cdot 0015...}{9751}\right)\right\}$$

$$= \frac{\cdot 0005...}{(9751)^{\frac{2}{3}}} + \text{smaller terms}$$

$$= \frac{\cdot 0005...}{456...} + ...$$

$$= 000001.$$

Again, therefore, the 6th place of decimals is the first affected.

If it be objected that the Binomial Theorem as applied to fractional integers is certainly outside the range of Arithmetic it is easy to avoid its use. Suppose $\sqrt{a}$ and $\sqrt{b}$ are nearly equal, so that

$$\sqrt{a} = \sqrt{b} + x \quad \text{wh. } x \text{ is very small.}$$
$$\therefore\ a = (\sqrt{b} + x)^3 = b + 3(\sqrt{b})^2 x + \ldots\ldots$$
$$= b + 3(\sqrt{b})^2 x \text{ very nearly.}$$
$$\therefore\ x = \frac{a-b}{3(\sqrt{b})^2}, \text{ which is the result used.}$$

But in fact this is merely the ordinary rule for the *abbreviation* of the process of finding the cube root.

6. Since A's speed in ascending is to B's as 3 : 2, B is $\frac{2}{3}$rds up his post when A reaches the top of his. B has, therefore, $\frac{1}{3}$ of his post left to climb when A commences to descend. But A descends twice as fast as he ascends, *i.e.*, 3 times as fast as B ascends. Hence A will meet B when A has done $\frac{3}{4}$, and B $\frac{1}{4}$, of the $\frac{1}{3}$ which B has still left to climb.

B has, therefore, climbed altogether

$$\tfrac{2}{3} + \tfrac{1}{4} \text{ of } \tfrac{1}{3}$$
$$= \frac{8+1}{12} = \frac{3}{4} \text{ of his post.}$$

7. (1) If n be any integer, we have

$$3^{(2n+1)} + 1 = (3^{2n+1} + 1)\,(3^{2(2n+1)} - 3^{2n+1} + 1)$$
$$= (3^{2n+1} + 1)\,(3^{2(2n+1)} - 3^{2n+2} + 2.3^{2n+1} + 1)$$
$$= (3^{2n+1} + 1)\,(3^{2n+1} - 3^{n+1} + 1)\,(3^{2n+1} + 3^{n+1} + 1).$$

This theorem, which is analogous to Aurifeuille's Theorem mentioned in 8 (2), was pointed out to me by Mr. T. P. Thompson, of Christ's College, Cambridge.

Applying this theorem :

$$3^{63} + 1 = (3^{21} + 1)\,(3^{21} - 3^{11} + 1)\,(3^{21} + 3^{11} + 1)$$
$$= (3^7 + 1)\,(3^{14} - 3^7 + 1)\,(3^{21} - 3^{11} + 1)\,(3^{21} + 3^{11} + 1)$$
$$= (3^7 + 1)\,(3^7 - 3^4 + 1)\,(3^7 + 3^4 + 1)\,(3^{21} - 3^{11} + 1)$$
$$(3^{21} + 3^{11} + 1)$$
$$= 2188 \times 2107 \times 2269 \times 10,460,176,057 \times 10,460,530,351. \quad \text{(A)}$$

But by writing $3^{63} + 1$ as $(3^9)^7 + 1$, it is clear that it is divisible by $3^9 + 1$.

i.e., by $(3+1)\,(3^2 - 3 + 1)\,(3^6 - 3^3 + 1)$,
i.e., by $(3+1)\,(3^2 - 3 + 1)\,(3^3 - 3^2 + 1)\,(3^3 + 3^2 + 1)$,
i.e., by $4 \times 7 \times 19 \times 37$.

The first of the factors (A) is divisible by 4.
,, second ,, ,, ,, ,, 7.
,, fourth ,, ,, ,, ,, 37.
,, fifth ,, ,, ,, ,, 19.

Hence finally :

$$3^{63} + 1 = 4 \times 7 \times 19 \times 37 \times 301 \times 547 \times 2269 \times 282,707,461 \times 550,554,229$$
$$= 4 \times 7^2 \times 19 \times 37 \times 43 \times 547 \times 2269 \times 282,707,461 \times 550,554,229.$$

All factors except the last two are primes. The last two *may* be so.

(2) $$4^{63} + 1 = 2^{126} + 1$$
$$= (2^{63} - 2^{32} + 1)\,(2^{63} + 2^{32} + 1).$$

Generally $2^{4n+2} + 1 = (2^{2n+1} + 2^{n+1} + 1)\,(2^{2n+1} - 2^{n+1} + 1)$, a result which is known as Aurifeuille's Theorem [*v.* 'Théorie des Nombres,' E. Lucas, T., i. p. 326, ed. 1891].*

Now $2^{63} = 9,223,372,036,854,775,808.$ [See next question.]

$2^{32} = 4,294,967,296.$

$$\therefore\ 2^{63} - 2^{32} + 1 = 9,223,372,032,559,808,513. \quad \text{(A)}$$
$$2^{63} + 2^{32} + 1 = 9,223,372,041,149,743,105.$$

There would be no way of factorising the first of these expressions further except by trial, were it not that there are several other ways of splitting $4^{63} + 1$ into factors.

Thus $4^{63} + 1 = (4^9)^7 + 1$, and is divisible by $4^9 + 1$,
i.e., by $(4^3 + 1)\,(4^6 - 4^3 + 1)$,
i.e., by 65×4033,
i.e., by $5 \times 13 \times 37 \times 109$.

Again, $4^{63} + 1 = (4^7)^9 + 1$, and is divisible by $4^7 + 1$, *i.e.*, by 16385.

i.e., by $5 \times 29 \times 113$.

Again, $4^{63} + 1 = (4^{21})^3 + 1$, and is divisible by $4^{21} + 1$, and, therefore,

by $4^{14} - 4^7 + 1 = 268419073$
$= 13 \times 20647621.$

We have now a selection of factors wherewith to test the quantities given above.

The G.C.M. of 20647621 and $2^{63} - 2^{32} + 1$ is 1429.

$\therefore$ $20647621 = 1429 \times 14449$, the first of which factors must divide into $2^{63} - 2^{32} + 1$, and the second into $2^{63} + 2^{32} + 1$.

Performing the division :

$$2^{63} - 2^{32} + 1 = 1429 \times 6,454,424,095,563,197. \quad \text{(B)}$$
$$2^{62} + 2^{32} + 1 = 5 \times 14449 \times 127,667,963,750,429.$$

It is easily verified that 1429 and 14449 are not divisible by the trial factors suggested above. They are, in fact, prime numbers.

We have still left us as factors 13, 29, 37, 109, and 113.

The shortest method of testing these is to find the G.C.M. of one of the expressions left at stage B and of the product :

$$13 \times 29 \times 37 \times 109 \times 113 = 171,809,833.$$

The G.C.M. of this and 127,667,963,750,429 is $3161 = 29 \times 109$.

Hence the 29 and 109 divide the second of expressions in B, and 13, 37, 113 divide the first.

Performing the divisions :

$$2^{63} - 2^{32} + 1 = 13 \times 37 \times 113 \times 1429 \times 118,750,098,349,$$
$$2^{63} + 2^{32} + 1 = 5 \times 29 \times 109 \times 14449 \times 40,388,473,189\ ;$$
$$\therefore\ 4^{63} + 1 = 5 \times 13 \times 29 \times 37 \times 109 \times 113 \times 1429 \times 14449 \times 40,388,473,189 \times 118,750,098,349.$$

The first eight factors of this answer are primes. The ninth and tenth are probably not primes, but it appears doubtful whether it is possible to decide this question without immense labour.

The most hopeful method would be to determine whether $4^{42} - 4^{21} + 1$ had a factor common to itself and either of these.

Since some of our readers may care to try this G.C.M. we may state that the value we obtain for $4^{42} - 4^{21} + 1$ is

19,342,813,113,829,668,748,787,713,

but we do not vouch for the correctness of this.

(3) $$4^{64} + 2^{64} + 1 = 2^{128} + 2^{64} + 1 = (2^{64} - 2^{32} + 1)\,(2^{64} + 2^{32} + 1)$$
$$= (2^{64} - 2^{32} + 1)\,(2^{32} - 2^{16} + 1)\,(2^{16} - 2^8 + 1)\,(2^8 - 2^4 + 1)$$
$$(2^4 - 2^2 + 1)\,(2^2 - 2 + 1)\,(2^2 + 2 + 1).$$

Now $2^2 = 4.$
$\therefore\ 2^4 = 16.$
$2^8 = 256.$
$2^{16} = 65,536.$
$2^{32} = 4,294,967,296.$
$2^{64} = 18,446,744,073,709,551,616.$

$\therefore\ 2^2 + 2 + 1 = 7.$
$2^2 - 2 + 1 = 3.$
$2^4 - 2^2 + 1 = 13.$
$2^8 - 2^4 + 1 = 241.$
$2^{16} - 2^8 + 1 = 65,281.$
$2^{32} - 2^{16} + 1 = 4,294,901,761.$
$2^{64} - 2^{32} + 1 = 18,446,744,069,414,584,321.$

The number 241 is a prime.

The number 65281, $= 97 \times 673$, and 673 is a prime.

There is no way of determining the factors, if there be such, of the other numbers, except by trial, dividing by all the prime numbers up to and including 65521 for $2^{32} - 2^{16} + 1$, and by a vastly more extended series for the other.

Ans. $\dfrac{3 \times 7 \times 13 \times 97 \times 241 \times 673 \times 4294901761}{\times\ 18446744069414584321.}$

8. In 400 calendar years we have

$$400 \times 365 + 3 \times 24 + 25 \text{ days} = 146097 \text{ days}$$
$$= 20871 \text{ weeks.}$$

It is clear, therefore, that the same date of the month is always the same day of the week.

Since the first of October, 1894, was a Monday, *i.e.*, 2nd day of week,

$\therefore$ the p^{th} of October will be the $\left\lceil \dfrac{p+1}{7} \right\rceil^{\text{th}}$ day of week,

where the symbol $\left\lceil \dfrac{a}{b} \right\rceil$ denotes the remainder when a is divided by b.

Since $365 = 7 \times 52 + 1$ for each year which has elapsed since the present, we add 1 to the day of the week ; $\therefore$ for the year N A.D.

* The example given in Lucas is incorrect. $2^{58} + 1 = 5 \times 107367629 \times 536903681$, and not as printed, a mistake which it may be as well to point out, since their discoverer says : 'Si ces facteurs venaient à se perdre le courage nous manquerait pour recommencer le travail, et il est probable que bien des âges passeraient avant qu'on ne réussit à les découvrir de nouveau.'

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we add $N-1894$. But for each leap-year we must add 2, not 1. In the period between 1892, the last leap-year, and N there are

$$\frac{N-1892-\left[\frac{N-1892}{4}\right]}{4} \text{ leap-years.}$$

[For clearly the number of complete groups of 4 contained in any number M is $\frac{M-\left[\frac{M}{4}\right]}{4}$.]

The 100's are not leap-years; ∴ from this figure we must subtract the number of hundreds, *i.e.*,

$$\frac{N-1800-\left[\frac{N-1800}{100}\right]}{100}.$$

The 400's are leap-years, ∴ we must add

$$\frac{N-1600-\left[\frac{N-1600}{400}\right]}{400}.$$

Clearly then the p^{th} Oct. in year N will be the remainder after division by 7 of

$$p+1+N-1894+\frac{N-1892-\left[\frac{N-1892}{4}\right]}{4}$$
$$-\frac{N-1800-\left[\frac{N-1800}{100}\right]}{100}+\frac{N-1600-\left[\frac{N-1600}{400}\right]}{400},$$

i.e., of $p+N-1893+\frac{N}{4}-473-\frac{1}{4}\left[\frac{N}{4}\right]$
$$-\frac{N}{100}+18+\frac{1}{100}\left[\frac{N}{100}\right]+\frac{N}{400}-4-\frac{1}{400}\left[\frac{N}{400}\right],$$

for $\left[\frac{N-1892}{4}\right]=\left[\frac{N}{4}\right]$;

since clearly $N-1892$ and N give same remainder on dividing by 4,

i.e., of $p+\frac{497N}{400}-2352-\frac{1}{4}\left[\frac{N}{4}\right]+\frac{1}{100}\left[\frac{N}{100}\right]-\frac{1}{400}\left[\frac{N}{400}\right]$

$$=\left|\frac{p+\frac{497N}{400}-\frac{1}{4}\left[\frac{N}{4}\right]+\frac{1}{100}\left[\frac{N}{100}\right]-\frac{1}{400}\left[\frac{N}{400}\right]}{7}\right|.$$

9. [For shortness denote the number 99 as 2-nine,
99999 as 5-nine, etc.]

If $\frac{1}{a}$ have p figures in its circulating period, a is exactly divisible into p-nine.

If $\frac{1}{b}$ have q figures in its circulating period, b is exactly divisible into q-nine.

If r be the L.C.M. of p and q, r-nine is the lowest nine-number which can be grouped either as p-nines or as q-nines, *i.e.*, the lowest nine-number which is divisible both by p-nine and by q-nine, *i.e.*, both by a and by b, and it is always so divisible if a is prime to b.

10. By trial of the successive primes it is readily found that

$$36,951974,377955 = 5\times7\times13\times37\times41\times53\times101\times137.$$

These numbers are all such that the reciprocals have short circulating periods.

$\frac{1}{7}$	has	6 figures
$\frac{1}{13}$	,,	6 ,,
$\frac{1}{37}$	,,	3 ,,
$\frac{1}{41}$	,,	5 ,,
$\frac{1}{53}$	,,	13 ,,
$\frac{1}{101}$	,,	6 ,,
$\frac{1}{137}$	,,	8 ,,

∴ $\frac{1}{7\times13\times37\times41\times53\times101\times137}$ has L.C.M. of 6, 6, 3, 5, 13, 6, 8 figures, *i.e.*, has 1560 figures.

∴ $\frac{1}{7\times13\times37\times41\times53\times101\times137}$ is a pure circulator with 1560 figures.

∴ $\frac{1}{10\times7\times13\times\ldots\times137}$ is a mixed circulator with one non-recurring, 1560 recurring figures, and the 1562nd as the first repeating figure.

∴ $\frac{2}{10\times7\times13\times\ldots\times137}$,, ,, ,, ,, ,,

∴ $\frac{1}{5\times7\times13\times\ldots\times137}$,, ,, ,, ,, ,,

11. It is a well-known theorem that if N be a prime, the number of figures in the period of $\frac{1}{N}$ is either $N-1$, or some sub-multiple of $N-1$.

∴ the number of figures in the period of $\frac{1}{98999}$ is either 98998, or some sub-multiple thereof. The only sub-multiples are 2 and 49499. Obviously there are more than 2 figures (for there are 4 zeros). Hence the circulating period contains either 49499 figures or 98998 figures. There is no means of deciding between these alternatives. Now if, by the method explained in Question 12, we find the figures which conclude the circulating period, we find them to be

... 135839755957130880l099001.

The working is (a part only being here reproduced) as follows :—

```
                99999(1009901
                98999
               -------
                99990100
                890991
               --------
                910891
                890991
               --------
                9901990
                98999
               --------
                89120
```

etc., etc.

The figures which commence the circulating period are by the ordinary process found to be

0000101011l2.....

Case I.—Supposing that there are 49499 figures in the period, the figures which close the first period and begin the second are then

... 135839755957130880l099001 | 0000101011l2
(49499th, 49499th, 49499th, 49500th)

and the statements in the question are now obvious, the first of the two alternative figures being taken.

Case II.—Suppose there are 98998 figures in the period. Then it is a well-known theorem that the

49500^{th} to 98998^{th}

figures can be obtained from the

1^{st} to 49499^{th}

by subtracting each of these latter group from 9.

[Thus $\frac{1}{7}=\cdot142857$, and 857 can be obtained from 142 by subtracting this from 999. So $\frac{1}{137}=\cdot007326$, and $926+073=999$, etc. It is universally true of all circulators with an even number of figures.]

In this case we must bear in mind that the figures written above, namely, those which close the first period, are no longer the 49499^{th}, but are as follows :—

... 135839755957130880l099001 | 0000101011l2 ...
(98998th, 98998th, 98998th, 1st)

Hence subtracting each figure from 9 the centre of the period is

... 864160244042869119890099 8 | 0999898988 87
(49499th, 49499th, 49499th, 49500th)

and the statements of the question are instantaneously verified about the second group of figures, the second of the alternative figures of the question being taken.

12. Consider the case of $\frac{1}{7}$ in scale 10. It is required to put this into the form $\frac{N}{999\ldots999}$;

$$\therefore 7N = 999\ldots999.$$

$7N$, therefore, has to end in 9; N, therefore, must end in 7.

Let it equal $10.M + 7$.

$$\therefore 7(10.M + 7) = 999 \ldots 999;$$
$$\therefore 70.M = 999 \ldots 950;$$
$$\therefore 7M = 999 \ldots 95.$$

M must, therefore, end in 5, etc.

The whole process may be arranged very similarly to division, thus :—

```
... 999(758241
     49
     ---
     95
     35
     ---
     96
     56
     ---
     94
     14
     ---
     98
     28
     ---
      7
      7
      -
      9
```

and as we have again reached 9, the work recurs.

$\therefore$ the period is 142857.

It is clear that this process is perfectly general for all fractions of the form $\frac{1}{p}$ in any scale, and can only fail when P ends in such a figure p, say, that either (1) no multiple of p can end in the figure $r-1$.

For instance, if $p = 5$, no multiple of 5 could end in the figure 9.

(2) More than one multiple of p can equal $r-1$.
It can be proved that this cannot happen when P is prime to p.
Suppose ap and bp both ended in the same figure.

$$\therefore ap - bp \text{ is divisible by } r,$$
$$\therefore (a-b)p \text{ is divisible by } r.$$

But $a-b$ is $< r$, for a and b are supposed digits, and p is prime to r.

$\therefore$ this is impossible.

Again, since, if p is prime to r, $1p$, $2p$, $3p$, $4p$, ... $(r-1)p$ all end in different digits, as we have just proved, and there are $r-1$ of them, one of them must end in the digit $r-1$.

Hence the process is always possible.

Case II.—Fraction $\frac{6}{7} = \frac{M}{999 \ldots 999}$.

$$\therefore 7M = 5 \ldots 9994;$$
$\therefore M$ is found as before.

```
5 ... 9994(241758
     14
     --
     98
     28
     --
     97
      7
      -
     99
     49
     --
     95
     35
     --
     90
     56
     --
     4,   and the work recurs.
```

This process is evidently also perfectly general. We apply it to the given example :—

$$\frac{1tee}{18237} = \frac{N}{\ldots\ldots cee};$$
$$\therefore 18237.N = 1tee \times (\ldots\ldots cee)$$
$$= \ldots\ldots ee101.$$

The process of finding N is then as follows :—

```
      ceet101(759,e18,1t72
       e9411
       -----
       e008e
       84e5e
       -----
       ee2713
       131883
       ------
       et80t5      tt317
       166135      18237
       ------      -----
       t41e7       ee920t
       18237       149tet
       -----       ------
       e87e8       et6e31
       115648      e9411
       ------      -----
       tt317       tt972
```

Multiples.	
1.	18237
2.	34472
3.	506t9
4.	68924
5.	84e5e
6.	t1196
7.	e9411
8.	115648
9.	131883
t.	149tet
e.	166135

The beginning of the period will be indicated when the remainder $t101$ is reached.

But we are informed that

$$\frac{1}{1e} + \frac{1}{31} + \frac{1}{35} = \frac{1tee}{18237}.$$

These fractions can be easily converted into duodecimals.

```
1e)100('06
   e6
   --
    6
```

But since 6 is $\frac{1}{2}$ of 10, the remainder of the figures can be found by division by 2.

```
6
3 carry 0
1  ,,  1
6  ,,  1
9  ,,  0
4  ,,  1
8  ,,  0
4  ,,  0
2  ,,  0
1  ,,  4
```

$$\therefore \frac{1}{1e} = \cdot 063,169,484,21.$$

and in similar fashion

$$\frac{1}{31} = \cdot 03t,852,32\dot{e}$$

$$\frac{1}{35} = \cdot 036,190,t65,327,739,7t9,e4e,85t,2e1,568,944,824,120,\dot{7}.$$

These fractions have respectively 11, 9, and 40 figures in their periods, $\therefore$ the sum of them has $11 \times 9 \times 40 = 3960$ figures, $\therefore$ the figures we have just found are the

3951st to 3960th.

The verification is instantaneous :—

```
                                          3960th
1/1e    = .....063169484210 63.....
1/31    = .....2e03t852320 3t.....
1/35    = .....894482412070 36.....
          ---------------------------
1tee/18237 = .....027t181e95 7
```

We have received the following neat *mental* solution to No. 1 in Paper I. from Mr. H. Lea, 37, Lugsmore Lane, St. Helens :—

1. The fifth root (approximately) of the large number given equals the middle number of the five required.
2. As the number contains 11 digits, the fifth root will contain *three*.
3. By inspection the hundreds digit of the fifth root is 1.
4. By inspection the number given contains *only three* 5's and *only three* 2's as factors.
   (*a*) Of any five consecutive numbers only one is a multiple of 5, hence one of the required numbers must contain the three 5's, and is therefore 125. [See (3).]
5. The five numbers may range from 121–125 to 125–129.
   (*a*) The sequence cannot be 121–125, for this contains only *one* 3, whereas the given number has at least two.
   (*b*) 128 can't be one, because it contains *seven* 2's.
   (*c*) 122 can't be one, because then *four* 2's would be required.

{122 = 2.61 ; 124 = 2 . 2.31 ; 126 = 2.63.}

Hence the numbers are 123, 124, 125, 126, 127.

Solutions differing from those we give will at all times be welcomed, and, if valuable, printed. Such solutions should be sent direct to W. P. Workman, Kingswood School, Bath, who will be glad to answer through these columns any questions bearing upon the papers.

WELL-KNOWN TEACHERS AT WORK.

XXXVIII.—MR. HARRY COWARD,

Head Master Anglesea Place Boys' School, Clifton, Bristol.

A two and a half hours' ride in an express from Paddington, will land you at Bristol, a stronghold of prelacy, if one can judge from the forest of spires and towers that meet the eye as we steam across the confines of the city. It is for Clifton, the most beautiful and plutocratic suburb of Bristol, we are making, and so we entrust ourselves to the skill of a Jehu, who puts us down at Anglesea Place Board School for the modest charge of half-a-crown. This school is situated at one extremity of the suburb, and within arrow range of the far-famed and invigorating stretch of common-land known as the Durdham and Clifton Downs, referred to by Macaulay in his 'Spanish Armada':—

'Right sharp and quick the bells all night rang out from Bristol town,
And ere the day three hundred horse had met on Clifton Down.'

There is nothing at all striking about the architecture of this school; in fact, the edifice is at once gloomy and unpicturesque. Let us, however, step inside, for here we are to meet the subject of our sketch and the object of our journey, Mr. Harry Coward, who is justly recognised as a mover in the front rank of West of England schoolmasters. We are met by the Head Master himself, who accords us a genial and hearty welcome. Meanwhile we mentally sum up our host. Mr. Coward is a gentleman in the prime of life, of commanding and almost military presence, of Saul-like stature, and of fine physique.

Yours faithfully,
Harry Coward

We should speedily infer, even if we did not already know, that his success in life is largely due to his unusual store of sound and clear judgment; his correctness and quickness in grasping a new situation; his interesting and cordial style as a conversationalist; his patience and attentiveness as a listener; his self-reliance, agreeable self-assertiveness, ready wit, and methodical business qualities. Mr. Coward strikes us from the first as being an ideal schoolmaster; one capable of moulding the characters of his pupils and magnetising them with the best attributes of manliness.

Now let us have a look at the building, an adapted voluntary school, which has been patched up and added to on various occasions. One would judge it a very inconvenient place to work in. Since the present master took charge, the average attendance has nearly doubled itself. The school is always full, and there would be many more scholars if there were room. There is a good museum, one of the most notable features of which is the entire absence of the usual cases of soap, candles, cocoa, and other advertisements. One of the assistants, Mr. Pilgrim, has the care of it.

Among other articles we noted birds' nests, eggs, compressed leaves, a case of butterflies, specimens of British and foreign woods, an interesting collection of fossils, some coins, a few models, specimens of antique books, printing, paper, etc., a pretty set of sea shells, and various ores.

The walls are adorned with some very pretty pictures, among which are pen-and-ink sketches and large coloured framed maps by the boys.

Then there is a library, which contains a goodly show of bound periodicals, such as the Boys' Own Paper, Cassells', Chambers', etc., books on adventures, history, science, etc. The works on natural history are in great request. All these are classified as far as possible according to their suitability for the respective standards. The books are issued by the senior assistant every Friday dinner-hour. The boys are much interested in the library, and the books, being largely their own contributions, are treated with great care.

The boys who attend this school are to a great extent children of the upper working class. Their cleanliness and general smartness strike one forcibly as one enters. We learn that amongst other features the Head Master makes an important point of home lessons, and himself encourages this work by offering prizes in every standard. The curriculum includes of course the ordinary subjects, together with Physical Drill, Algebra (Stages I., II., and III.), Mechanics, Mensuration (Stages I., II., and III.), and Shorthand.

That the Government Inspectors have the highest opinion of the work done by Mr. Coward is evident from the reports received and the grants earned. In the time of the now defunct merit grant the award Excellent was always gained, and since then the

highest grants have continued to be received. The following extracts from the most recent reports show the opinions of H.M.I.:—

1890. 'In a highly satisfactory condition. The instruction is in all respects intelligent and successful. Special commendation is due for military drill and singing, which are singularly good.'

1891. 'The school continues to be very well organised.'

1892. 'This school is very well organised and under good discipline, and both the elementary and class subjects give evidence of careful and intelligent teaching. The singing by note and military drill deserve special praise.'

1893. 'The discipline and organisation are very satisfactory. The elementary work gives evidence of very careful teaching. The class and specific subjects have been well prepared.'

In recognition of the previous good work of the school, the Education Department excused the examination in 1894 under Art. 84 of the Code. The grant paid amounted to £235 9s. 6d. for an average attendance of 217, that is £1 1s. 8¼d. per head. The physiques of the youthful Cliftonians are naturally not neglected by a gentleman of Mr. Coward's fine build. Swimming, cricket, football, and drill provide ample scope for the Spartan side of their training, and not a few are devotees of the wheel. The second assistant, Mr. W. E. Braund, has displayed considerable enthusiasm in the athletic department, more especially with cricket and football.

During the past year about 1,000 tickets for the Kingsdown Swimming Baths have been sold. Owing to the generosity of the Bristol Humane Society, these tickets are procurable by children in the primary schools at the low charge of one penny. Many boys have thus learnt to swim, whilst a few others have received lessons in swimming at the baths belonging to the School Board. Sergeant Flynn, a stalwart Hibernian ex-warrior, is the peripatetic drill-instructor of the Bristol School Board. Armed with no more deadly weapon than a short cane, this native of the Emerald Isle attends the school once a week, and puts the lads through various military evolutions. The honours boards which adorn the walls are filled with the names of scholars who have won exhibitions at the well-known local secondary schools. The Head Master is a practical advocate of an unimpeded track from the gutter to the University for all whose abilities are equal to the task. Anglesea Place School has achieved a unique reputation in the educational-ladder line. This is one of the most successful and gratifying features of the school. The annual report just issued states that scholarships to the value of £585 have been gained this year. The total value of the scholarships earned since 1883 amounts to £4,145. These exhibitions are tenable at the Merchant Venturers' Technical College, the Bristol Grammar School, the Colston School, and Queen Elizabeth's Hospital. The annual report mentioned above continues: 'The attention of parents is specially directed to the various scholarships offered, from time to time, to our boys. We shall always be pleased to give any information and assistance in connection with them.'

Another pleasing feature of the school is the annual collections made by the boys on behalf of the Children's Hospital and the Children's Help Society. In connection with West Bristol Flower Show and Home Encouragement Society, as many as 19 scholars carried off prizes for handwork and flowers at the last exhibition. A well-known ardent Unionist and enthusiastic educationist himself, one is not surprised to find Mr. Coward surrounded by an able and energetic staff. The gentleman in charge of the first class is the senior assistant, Mr. Wm. L. Dowding, of whom Mr. Coward has the highest opinion. Mr. Dowding was trained at Battersea in 1888–89, where he passed in the first class at the Certificate Examinations, and received special commendation for his practical teaching abilities. Since leaving college he has been in great demand as a coach for teachers' examinations, and holds the post of Geography Lecturer at the School Board's Pupil Teachers' Centre. He is the Vice-President of the local branch of the N.U.T., has served on the Committee since 1892, and has taken a prominent position in the Assistants' Association from its start, *being President for* 1895. He has also for the past three years been the secretary of the Bristol Board Teachers' Association. The second master, Mr. W. E. Braund, is the Vice-President of the local association of assistant teachers. Of one and all, the Head Master speaks with cordial appreciation, and it is manifest that the relations between him and his lieutenants are of a most harmonious nature. The

ANGLESEA PLACE BOARD SCHOOL, BRISTOL.

Morning.			Afternoon.					
Time.	Standard.	——	Time.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
8.50—9.0	All	Boys assemble.	1.50—2.0.	Boys assemble.				
9.0—9.5	All	First Marking of Registers.	2.0—2.5	First Marking of Registers.				
9.5—9.15	All	Opening Service.	2.5—2.45	V.—VII. Mechanics (specific) I.—IV. Arithmetic	V.—VII. Algebra (specific) I.—IV. Arithmetic	V.—VII. Mechanics (specific) I.—IV. Reading	V.—VII. Singing I.—IV. Writing	III.—VII. Arithmetic I.—II. Singing
9.15—9.45	All	Scripture Lesson.						
9.45—10.0	All	Examination of Home Lessons and Final Marking of Registers.	2.25—2.30	Final Marking of Registers.				
			2.45—3.15	English	Geography	English	Geography	Recitation
10.0—10.45	All	Arithmetic (except Friday, when Drill is taken).	3.15—3.25	Recreation.				
10.45—11.0	All	Recreation, Singing, or Physical Exercises.	3.25—4.0	Drawing	Reading	Drawing	Reading	Reading
11.0—11.30	All	Reading.						
11.30—12.0	I.—IV.	Transcribing, Dictation, or Spelling.	4.0—4.30	Drawing	VI.—VII. Shorthand I.—IV. Spelling	Drawing	V.—VII. Map Drawing III.—IV. Singing I.—II. Tables	Writing
11.30—12.0	V.—VII.	Composition, Dictation, or Writing.						
12.0	All	Dismissal.	4.30	Dismissal.				

NOTE.—The Time Table is arranged, as far as possible, for the same subject to be taken at the same time in all the classes.

PUPIL TEACHERS.—Instruction is given in Centre Classes on Monday and Wednesday Evenings, and on Saturday Mornings. They also receive instruction at their own School from Head Master on Tuesday, Thursday, and Friday Mornings from 8 to 9 a.m. They receive private study each day from 9 to 9.45 a.m.

C. H. B. ELLIOTT, H.M.I.S.

assistants make their own interests identical with those of the school. As Mr. Dowding said to me, 'The modern assistant teacher recognises his own responsibility in the conduct of the school, and is alive to the fact that he shares not only its work but its success.'

Of past assistants mention must be made of Mr. Moorhouse, now Head Master of Greenacres Endowed School, Oldham, who did excellent service, and Mr. Somerton, now senior assistant at Mina Road Board School, Bristol, who did much to establish the athletic reputation of the school.

After going the round of the school, we ventured to interrogate our host as follows:—

'Will you oblige us with a brief outline of your professional career up to date?'

'With pleasure. I was a pupil teacher at the Boys' School, Warminster, and so my youth was spent among the chalky uplands of Wiltshire, a bucolic county, containing Salisbury Plain, where one may wander for miles and see nothing but shepherds, sheep, and cairns. At the end of my apprenticeship I was fortunate enough to get into Borough Road College, where I was trained during 1874–5. After leaving, I served as Head Master of a rural school in Gloucestershire for six years, and 12 years ago I was appointed to my present school. I am the lecturer in English at the Board's Central Classes for Pupil Teachers, and was one of the lecturers at the Evening Classes for Acting Teachers, formerly held at the University College.'

'To what do you attribute your success as a schoolmaster?'

'That is a difficult question to answer. I have always had an enthusiasm for teaching, and even as a pupil teacher had but little trouble with the boys. I have always made a point of *knowing* my whole school, and hope every boy personally feels I take an interest in him. Each class is visited by me for longer or shorter time, every morning and afternoon. I have tried to avoid allowing my school to drift into the condition of being a mere collection of classes totally distinct from one another. Freedom of classification has been latterly freely and fairly used with much success. The greatest reason of our doing well has been undoubtedly the cordial relations existing between all the members of the staff towards one another and towards myself. From the senior assistant to the pupil teachers one and all are animated with a desire to do their work well. Of my old pupil teachers two deserve mention; Mr. W. Mizen, who was near the top of the Scholarship List in 1891, and Mr. H. Padmore, the successful Master of the Swanage Board School. The Bristol School Board has always treated us well, readily agreeing to my suggestions for the good of the school. The parents are very proud of our school. I endeavour to foster this connection with the parents by, among other things, issuing an annual report of progress, scholarships, prize lists, etc., etc., which I have reason to know is much valued by them. With regard to discipline, of course I am an uncompromising upholder of the right of the teacher to administer corporal punishment when necessary, but at the same time I can safely say that I have never, as a schoolmaster, dealt with a boy in a manner which I should object to, were it used under similar conditions in the case of my own son.'

'Now let us hear your record of work outside on behalf of your fellow teachers. What offices have you held in the local Teachers' Associations or N.U.T.?'

'I have held the offices of Treasurer, Vice-President, President, and ex-President of the local branch of the National Union of Teachers, and have for 12 years been a Committee-man. For many years I have been chosen a representative to Conference, and have addressed a large number of Union meetings throughout the West of England. Of the Board Teachers' Association, of which I was one of the founders, I am at present President for the second time. I have been its Secretary, and have served on the Committee since its formation.'

Mr. Coward is rightly regarded as a leader among the teachers of the West of England. He is a strong Unionist, and has a great belief in the future possibilities of the Union for good. He is a candidate for the Executive, having been nominated by the Bristol Association in the place of ex-President Walker, whose recent illness prevents him from standing again. Mr. Coward puts forward a sound progressive programme, and places pensions and a more rational system of education in the forefront. He believes that higher grants should be paid for pupil teachers to meet the extra expense incurred by class teaching, and is strongly of the opinion that too many subjects at present crowd the Code.

Mr. Coward takes great interest in the charities, and over £50 have been collected by him during the past year or two. He is anxious to strengthen this part of the Union's work, and thinks the funds would benefit if they were more directly controlled by the Union.

OUR PUPIL TEACHERS' COURSE.

BY GEORGE COLLAR, B.A., B.SC.,
Head Master of Stockwell Pupil Teachers' School, London.

SCHEME OF WORK FOR THE MONTH.

A.—*English.*

(i.) *First Year.*
The Noun.—Classification, person, gender, number, case. Suffixes used to form nouns.
See Beach, 13–32, and parts of 198–202; Morris, 20–35, 89, 93, 94, 96; Daniel, 4–32, 304–5, 308–10, 312.

(ii.) *Second Year.*
Examples in Analysis and Paraphrasing.
See Dawson's 'Essay-writing and Paraphrase.' (Hughes and Co.)

(iii.) *Third Year.*
Tests by which English words may be distinguished from those of foreign origin. (See below.)

B.—*Arithmetic.*

(i.) *First Year.—Boys.*—Compound and Complex Fractions. See Lock, pp. 103–109; Pendlebury, pp. 103, 105, 113–116; C. Smith, pp. 98–102.

Girls.—Factors, Measures, Multiples, Greatest Common Measure, Least Common Multiple. The closest attention is necessary to the theory in this portion of Arithmetic. See Lock, pp. 67–80; Pendlebury, pp. 20–32; C. Smith, pp. 67–82; Dixon and Beach, pp. 72–76.

(ii.) *Second Year.—Boys.*—Profit and Loss. See Macmillan's 'Arithmetic for the Standards,' VII., pp. 18–27. See Lock, pp. 265–272; C. Smith, pp. 179–186; Pendlebury, pp. 208–216.

Girls.—Same as First Year Boys.

(iii.) *Third Year.—Boys.*—Revision of Vulgar Fractions, particular attention being paid to the theory, and to the methods of teaching the various rules. Work miscellaneous examples on Vulgar Fractions.

Girls.—Multiplication and Division of Recurring Decimals by whole numbers or by non-recurring decimals, without reducing to vulgar fractions. Multiplication and Division *by* recurring decimals. See Lock, pp. 155–160; Dixon and Beach, pp. 107–110; C. Smith, pp. 130–138; Pendlebury, pp. 142–144.

C.—*Euclid.*

(i.) *First and Second Years and Third Year Girls.*—To end of Proposition XXV.

(ii.) Revision of Propositions I.–XV. Classification of the Propositions. Deductions on Propositions I.–XV.

D.—*Algebra.*

(i.) *First and Second Years and Third Year Girls.*—Simple Equations with one unknown, and Problems which may be solved by their aid.

(ii.) *Third Year.—Boys.*—Highest Common Factor, Lowest Common Multiple, Fractions. (Apply the rules for finding factors to each of these rules.)

E.—*Mensuration.*

As the Mensuration for Third Year is so small in amount, students should go on with the Fourth Year (Scholarship) course at once. The Circle: relations (*a*) between the diameter and circumference; (*b*) between the diameter and area; (*c*) circumference and area.

F.—*Teaching.*

(i.) *Second Year.*—A careful study of Flux's 'School Management,' Ch. IV.

(ii.) *Third Year.*—Flux's 'School Management,' Ch. IX.

G.—*Geography.*

All Years.—General Geography of Australia, with revision of map of England and Wales.

H.—*History.*

All Years.—Reign of Henry II.—his quarrel with the Church—Becket—his legislative and judicial reforms—Constitutions of Clarendon—foreign relations and possessions—personal character and family quarrels.

TEST QUESTIONS ON LAST MONTH'S WORK.

First Year.—1. What is the difference between a direct object and a complement? Some people in analysing put the complement in the same column as the verb, but put the object in a separate column, is there any reason why this should be done?

2. Analyse the following, and parse the words in italic:—

The schoolboy, *wandering* through the wood
To pull the primrose *gay*,
Starts the new *voice* of spring *to hear*,
And *imitates* thy *lay*.

3. Explain by means of a diagram that $\frac{4}{5}$ of $\frac{3}{3} = \frac{8}{15}$. Divide $1\frac{1}{3}$ of $\frac{7}{8}$ of $\frac{5}{6}$ by $1\frac{1}{3}$ of $\frac{3}{7}$ of $\frac{1}{4}$.

4. What is meant by dividing one quantity by another? How is it that when a number is divided by a proper fraction the quotient is greater than the dividend.

Second Year.—1. Explain the difference between a simile and a metaphor.

2. What is meant by—antithesis, tautology, climax, allegory.

3. The average of eight numbers is 9·45, the average of the first seven of them is 8·75; find the eighth.

4. How many gallons of wine at 25s. per gallon must a wine-merchant mix with 8 gallons at 38s. per gallon in order that the average price may be 33s. per gallon?

5. The average price of a certain number of books was 3s. 6d. each, twenty of them were worth 4s. 9d. each, and the rest were worth 3s. 3d. each. How many books were there?

Third Year.—1, 2. English as above. (Second Year, 1, 2.)

3. Paraphrase:—

Full fathom five thy father lies:
Of his bones are corals made;
Those are pearls that were his eyes:
Nothing of him that doth fade,
But doth suffer a sea-change
Into something rich and strange;
Sea-nymphs hourly ring his knell:
Hark! now I hear them—
Ding, Dong, Bell.

4. What is a unit quantity? What is the difference between a compound expression and a simple one?

5. Give a sketch of the diagrams you would use in teaching Square Measure, especially in showing that 30¼ square yards make one square perch.

6. What is a *decimal*, a *recurring decimal?* How can you tell *by inspection* whether a vulgar fraction will reduce to a non-recurring or a recurring decimal?

7. State the rule for converting a recurring decimal into a vulgar fraction, and *prove* that $\cdot 07\dot{2}3\dot{5} = \frac{7228}{99900}$.

Algebra.

(i.) 1. The product of two expressions is $8x^3 + y^3 - 6axy - 2a^2x - a^2y$, and one of them is $4x^2 + y^2 - 2xy - ay - 2ax$, find the other.

2. Multiply $81a^4 - 27a^3b + 9a^2b^2 - 3ab^3 + b^4$ by $3ab + b^2$.

(ii.) 1. Find the factors of $x^2 + 11x + 28$, $x^2 - 11x + 28$, $x^2 - 3x - 28$, $x^2 + 3x - 28$.

2. What are the factors of $x^4 + a^2x^2 + x^4$?

Teaching.

Second Year.—1. What are the chief uses of the black-board in teaching? Give a few rules for employing it.

2. Describe a few simple experiments that you might use in giving an object lesson.

Third Year.—1. Which should be taught first, and why, Parsing or Analysis?

2. Give a selection of pieces of poetry suitable for recitation in Standard III., and say what makes them appropriate.

3. What advantage should children gain from a course of lessons on word-building?

Geography.—For all Years.

1. Describe the river-systems of British North America.

2. In what does the mineral wealth of Canada consist? To what extent is it worked?

3. Give an account of the Canadian Pacific Railway.

4. In what respects does the government of Newfoundland differ from that of the other provinces in British North America? Say what you know of the present state of Newfoundland.

5. Say what you know of the following:—Ottawa, Halifax N.S., Victoria, Montreal, Fort Garry, St. John, St. John's.

History.—For all Years.

1. Summarise the chief duties (*a*) of the lords to their vassals, (*b*) of the vassals towards their lords, under the Feudal system.

2. Trace the progress of Norman influence in England up to the death of Edward the Confessor.

3. On what grounds did William I. claim the English crown? In what ways has the English nation benefitted by the Norman invasion?

4. Give an account of Robert, Duke of Normandy.

5. Explain the meaning of the following terms:—Scutage, aid, ward, tenant *in capite*, purveyance.

HINTS ON LAST MONTH'S QUESTIONS.

First Year.—An Intransitive Verb or a Transitive Verb in the Passive Voice may be used with a subject to make a complete statement, as—'Birds fly'; 'the box was broken.' They are therefore called Verbs of Complete Predication, but if a verb is unable to make a complete assertion about the person or thing denoted by the subject it is called a Verb of Incomplete Predication, *e.g.*:—'The boy *broke* his slate'; 'the weather *is* cold'; 'his brother *was* a soldier.' Verbs of Incomplete Predication are divided into two classes, Transitive Verbs and Copulative Verbs. When the verb conveys the idea of an action passing on to or affecting the person or thing denoted by the Completion, the verb is called a *Transitive Verb*, and the Completion is called the *Object*; but when the Completion denotes the same person or thing as the subject does, or a quality or property pertaining to that person or thing, and the verb merely couples them together, the verb is called a *Copulative Verb*, and the Completion is called the *Complement*. The Object of a Finite Transitive Verb is put in the Objective Case, but the Com-

plement of a Finite Copulative Verb is put in the Nominative, if it is a Noun or Pronoun, *e.g.*:—'We have seen *them*'; but, 'It was *I*.'

Third Year.—2.

$$\begin{array}{r|l} 7 & 7\,8\,3\,2\,6\,4 \\ 5 & 1\,1\,1\,8\,9\,4 \quad , 6 \\ & 2\,2\,3\,7\,8 \quad , 4 \end{array} \Big\} 4 \times 7 + 6 = 34.$$

On dividing by 7 we find that the number consists of 111894 sevens and 6 units over. On dividing these sevens by 5, we find that they consist of 22378 groups of five times seven (*i.e.*, thirty-fives) and 4 sevens over. The total remainder, therefore, is 4 sevens and 6 units, that is 34.

3. (*a*) It should be noted that the numbers 15, 36, 39 are in the proportion 5, 12, and 13, so that the triangle is a right-angled triangle (Euclid I. 47); its area—

$$= \frac{15 \times 36}{2} \text{ ft.} = 270 \text{ sq. ft.}$$

(*b*) For the sake of explaining the method of extracting the square root by factors let us apply the formula—

$$\text{area} = \sqrt{s\,(s-a)\,(s-b)\,(s-c)};$$

$$s = \frac{15 + 36 + 39}{2} = 45;$$

$$\therefore \text{area} = \sqrt{45 \times (45-15) \times (45-36) \times (45-39)}$$

$$= \sqrt{45 \times 30 \times 9 \times 6};$$

factorising we get

$$\sqrt{3 \times 3 \times 5 \times 5 \times 3 \times 2 \times 3 \times 3 \times 3 \times 2};$$

rearranging we get

$$\sqrt{(3 \times 3) \times (5 \times 5) \times (3 \times 3) \times (3 \times 3) \times (2 \times 2)},$$

which is equal to

$$3 \times 5 \times 3 \times 3 \times 2 = 270.$$

Ans. 270 sq. ft.

Notes on the Work for the Month.

English.—In teaching Parsing and Analysis, the most common fault is to begin with exercises before the principles have been mastered. I have heard a young teacher hold up a piece of chalk and tell his class that it was a Noun, and I have not unfrequently come across the definition of an Abstract Noun as the name of something that cannot be seen. With reference to the first error it cannot be too strongly insisted on that the Noun is the *name* of the thing and not the thing itself, and the student will have no difficulty in thinking of many Concrete Nouns which are the names of invisible things, such as *air*, *oxygen*; while many Abstract Nouns are names of things which appeal to our sense of sight, as *whiteness*.

The distinction between *names* and *things* must be borne in mind throughout; thus *Gender* is applied to words, and *Sex* to living things and persons. To describe a lady as a being of the feminine gender is a gross error, and is never taken for a display of wit, but rather as a sign of the want of it.

Tests by which English words may be distinguished from those of Foreign origin.

No set of rules can possibly be given which will enable a student to distinguish in every case words of English from words of foreign origin. Even our best philologists sometimes make mistakes, but there are certain characteristics which serve as guides in a very large number of cases.

If we take the total number of words in the dictionary we find that more than two-thirds are of foreign origin, yet we say that English is a Teutonic language. The fact is that the dictionary includes vast numbers of words that are very seldom used, so that if we take the words used in every-day life we shall find a vast majority of Anglo-Saxon origin.

Words can be divided into two great classes, *notional* and *relational* words. Certain words when used convey a definite notion to our minds, *e.g.*, cow, write, house, white, these are consequently called notional words; speaking generally, nouns, verbs, and adjectives are notional words. Other words have no meaning at all in themselves, but serve to show the relation between those that have. Thus, if we say, 'General Wolfe fought *and* fell *at* Quebec,' the words 'and' and 'at' have no meaning in themselves, but 'and' serves to show the relation between 'fought' and 'fell,' viz.: that both acts were done by the same person, and 'at' puts the noun 'Quebec' in relation to the rest of the sentence as indicating place. So, generally speaking, conjunctions, prepositions, and the verb 'to be' are relational words. Now Early English possessed a sufficient number of notional words to stand for the notions of the people using it, and a complete set of relational words for connecting them together. As time went on and new notions came in, foreign words were generally introduced to stand for them. We can therefore say—

I. Relational words are of English origin. (*Till* and *are* are of Scandinavian origin however.)

II. Words denoting simple ideas, and names of things known to and used by our Anglo-Saxon forefathers are English, *e.g.*, sheep, father, water, milk.

The student must not assume that because a noun looks simple and is the name of something *now* in common use that it is necessarily of English origin; thus *tea* is Chinese.

III. All strong verbs and nouns are of English origin, *e.g.*, man, goose, run, steal.

IV. All nouns forming their plurals in *-en*, *-ves*, as knife, ox.

V. All words containing a hard *g* before *e* or *i* are English, as give, begin, get. (Compare with *engine*, *general*, which are Latin.)

VI. As there is no *w* in Latin, words containing that letter are of English origin, as winter, who, wish. (One or two Latin words containing a *v* passed into English at a very early period and changed *v* into *w*, as *vallum* = *wall*.)

VII. The combinations *gn*, *kn*, as gnaw, knight, are peculiar to English words.

VIII. The combination *-ough*, which now has such a variety of sounds, but was formerly a guttural, is a sign of Saxon words, so is *y* used as a consonant—rough, young.

IX. A knowledge of the prefixes and suffixes is of great use in enabling us to tell the source of a compound word, for as a rule English prefixes and suffixes are used with English roots, etc., as *un*-tie, but *in*-cap-*able*, *hypo*-thesis, which are English, Latin, and Greek respectively.

Sometimes, however, English prefixes and suffixes are used with Latin roots, and *vice-versa*, as *un*-punctual, *sub*-way.

N.B.—Such compounds are called hybrids.

X. The letter *y* as a vowel in the middle of a word is a sign of Greek origin, as physical, abyss.

This rule does not apply to such words as relying, in which *-ing* is only an inflexion, nor to rhyme (also spelt rime), the spelling of which is due to confusion with rhythm, which is Greek.

XI. *Ph*, *ps*, are signs of Greek origin—photograph, psalm.

XII. Initial *rh*, and *rrh* in the middle or end of words are signs of Greek origin—rhetoric, catarrh.

Scholarship—Fourth Year.

Work for March.

English—Literature.—Rise of the Drama. Miracle Plays, Moralities, Renaissance; Ralph Roister Doister, Gorboduc; Elizabethan Dramatists—Lyly, Peele, Greene, Marlowe, Shakespeare, and Ben Jonson. Particular attention should be paid to Shakespeare's life and works; see Green's 'Short History of the English People.'

Grammar.—Adverbs, Conjunctions, Prepositions.

Arithmetic.—*Girls.*—Discount and Compound Interest.

Boys.—Cube Root, Revision of Simple Rules, Factors, L.C.M. and G.C.M. Theory, methods of teaching these rules.

Algebra.—Quadratics. Formation of Quadratic Equations. Solution (*a*) by means of factors, (*b*) by formula.

Euclid.—Props. I.–XV. with deductions.

Mathematics (for Girls). See First Year Boys.

Geography.—Complete the Geography of Europe. Map of India.

History.—To deposition of Richard II.

School Management.—Flux, Chapter VII.

Domestic Economy.—Washing, warming, cleaning, and ventilation of the dwelling.

Music.—Various forms of the Minor Scale, intervals found in it. Meaning of the more common musical terms.

Test Questions on Last Month's Work.

1. Give a short account of the writings of Spenser.

2. What do you understand by Euphuism, who introduced it, and what references to it are found in later writers?

3. What do you consider the best definition of a Verb? Mention others that are commonly given and say where they are faulty.

4. What is a Conjunction? How many conjunctions are there in English? Which is the living one?

5. What sum of money put out for 5½ years at 3½ per cent. will amount to £953 0s. 1½d.?

6. In what time will £859 amount to £987 17s. at 5 per cent. per annum simple interest?

7. What do you know of the following places:—Drammen, Eskilstuna, Gottenburg, Trondhjem, Malines, Bruges, Haarlem, The Hague.

8. Give a sketch of the industries of Denmark.

9. Write a short account of the Commerce of Holland.

10. Write a life of Simon de Montfort. What great political changes did he introduce?

11. Compare the Continental possessions of the English King in 1199 and 1216. In what way was the loss of Normandy a gain to the English nation?

12. What are Mulhäuser's four 'elements' in the small script letters? What are the advantages of Mulhäuser's method of teaching writing?

ANSWERS TO CORRESPONDENTS.

WORTLEY.—(1) Take Science Subject I. (2) No. (3) Science results will be out before Certificate Examination, or at any rate the results will be in time to be counted. Our advice is to work so at your science that you will have no need to fall back on a language in case of failure.

'But screw your courage to the sticking point
And we'll not fail.'—*Macbeth.*

ANTONIO.—(1) You are to blame for not seeing which paper you took. The regulations came in force before your examination. (2) Take Subject I. in May; apply at once.

NEW PROBLEMS IN ARITHMETIC.

BY T. B. ELLERY, F.R.G.S.,
Vice-President National Union of Teachers.

6TH PAPER.

STANDARD I.*

FOR introduction, *see* October No. of *The Practical Teacher*. For other remarks on the same subject I refer my readers to the *Girls' Mistress* for September 1st last, in which appears the first of a series of papers on *Standard Problems for Girls, and How to Solve them*. In passing let me say:—

1. Every exercise here given will suggest to the practical teacher many others of the same kind.
2. The blackboard should be freely used in the solution of these problems.

Many of these exercises may, perhaps, be considered too difficult for Standard I., but they are set for the purposes of blackboard lessons, and as a preparation for the work of Standards II. and III.

Each exercise should be written on the blackboard, read by the teacher, and then by the children. Every effort should be made to encourage the little ones to think, and to this end preliminary mental practice should be given before any one problem is attempted.

A.

1. Take 86 from 250, and add your answer to ninety-seven.

2. There are 216 sheep in one field and 305 in another. How many are there in one field more than in the other?

3. If you had 120 nuts and lost fifty-seven of them, how many would remain?

4. A farmer had 25 cows. He then bought 16 more and afterwards 18 more. How many had he then?

5. There are 56 boys in the first class, 62 in the second, and 54 in the third. How many altogether?

6. If I have 246 marbles and give away 99, how many have I left?

7. Take the sum of 17, 23, and 39 from a hundred and fifty.

8. Take 38 from 90, and then take sixteen from what is left.

9. There are 65 boys in a class. Each has a reading book, and there are 36 books to spare. How many books are there in all?

10. 183. 241.
Make your own sum and subtract.

11. A man gave away 24 apples, then 18, then 20, and then 12. If he had 48 left how many had he at first?

12. What must you add to the sum of 125 and thirty-seven to make three hundred?

B.

13. A boy had 450 marbles. He gave 86 to his brother and afterwards lost 120. How many left?

14. There were two hundred sheep in a field. Fifty of these were sold and 38 killed. How many left?

15. I had 130 marbles. I then bought 60 more and afterwards lost 17. How many had I then?

16. Tom had 34 pennies and his brother had 18 more than that number. How many had they together?

17. Fred has 16 apples, Tom 14, and Harry 18. How many less than 50 have they altogether?

18. I had 16 apples in each of 4 baskets. How many had I in all?

19. I had 84 oranges. I gave 24 to one class, 19 to another, and 15 to another. How many left?

20. Mary had 58 pins; Emily 16 more than that number. How many had they together?

21. There are 36 houses on one side of a street and two more than that number on the other side. How many houses in the street?

22. Fred has 168 marbles and Harry has 37 more than Fred. How many has Harry?

23. A lad had 42 marbles and then won 16 more. If he gave 26 to his brother, how many had he for himself?

24. There are 250 boys in a school. One morning 46 boys were absent and 8 boys came late. How many were early?

25. There are 180 children in the boys' school, 166 in the girls' school, and 175 in the infants' school. One morning there were 38 children absent altogether. How many were present?

* Standard II. children should work these exercises before attempting Standard II. problems.

26. There are 428 apples on a tree. 76 are blown down and are thrown away, and the rest are given to the boys in a certain school, each boy having one. How many boys in the school?

27. There are 60 apples in one basket and 42 in another. How many more must I put into the second basket so that I may have as many in it as in the first?

28. A boy earned 8 pennies on one day and 9 on the next. His father then gave him six more. He bought some apples, for which he paid 3 pennies. How many pennies had he then?

C.

29. I give 17 nuts to each of 2 boys and 25 to each of three girls. How many do I give away?

30. I have 40 oranges. I give one half of them to one boy and a dozen to another. How many left?

31. A boy had 85 marbles. He gave away 16, then he bought 24 more, and afterwards won ten more. How many had he then?

32. There are 96 boys and 87 girls in a certain school. To every one who was early one morning a penny was given. If 164 pennies were given away, how many children were late?

33. I had 15 pins in each of 3 boxes. If I lost nine, how many would remain?

34. There are four desks in a certain room. At each of three of them 8 boys are seated, and at the other there are six. How many boys in all?

35. I gave 8 loaves to each of 4 women and had a dozen left. How many had I at first?

36. Each of 4 boys took 3 apples out of a basket and then there were 28 left. How many were in the basket at first?

37. 2 oranges are given to each of 56 boys in the boys' school, 48 girls in the girls' school, and 25 infants in the infants' school. How many oranges are given away?

38. There were 53 boys in a class. A man gave 3 buns to each boy and had 14 buns left. How many buns had he at first?

39. A man bought 126 sheep and then 258 more. He afterwards sold 72 to one farmer and 85 to another. How many had he then?

40. A woman bought 36 apples on Monday and on Tuesday sixteen. If she gave two to each of her three children how many would be left?

41. There are 54 slates in the first class, 63 in the second class, and 48 in the third class. In each class two slates are broken. How many sound slates are there altogether?

42. How many nuts should I require to give 18 boys and 16 girls two each?

43. Dick, Sam, and Willie had 18 nuts each. A gentleman then gave each of them 12 more. How many had they altogether then?

44. Three girls had 32 pins each. One lost 8, the second gave away six, and the third gave away 7. How many had they altogether then?

ANSWERS.

(1) 261.
(2) 89 sheep.
(3) 63 nuts.
(4) 59 cows.
(5) 172 boys.
(6) 147 marbles.
(7) 71.
(8) 36.
(9) 101 books.
(10) 58.
(11) 122 apples.
(12) 138.
(13) 244 marbles.
(14) 112 sheep.
(15) 173 marbles.
(16) 86 pennies.
(17) 2 apples.
(18) 64 apples.
(19) 26 oranges.
(20) 132 pins.
(21) 74 houses.
(22) 205 marbles.
(23) 32 marbles.
(24) 196 boys.
(25) 483 children.
(26) 352 boys.
(27) 18 apples.
(28) 20 pennies.
(29) 109 nuts.
(30) 8 oranges.
(31) 103 marbles.
(32) 19 children late.
(33) 36 pins.
(34) 30 boys.
(35) 44 loaves.
(36) 40 apples.
(37) 258 oranges.
(38) 173 buns.
(39) 227 sheep.
(40) 46 apples.
(41) 159 sound slates.
(42) 68 nuts.
(43) 90 nuts.
(44) 75 pins.

OUR 1895 CERTIFICATE CLASS.

BY J. C. HOROBIN, M.A.,
Principal, Cavendish College, Cambridge.

Notes on the Play.

1. An absolute kingly character:—

Passionate, Wayward, Domineering	becoming	Jealous, Exacting, Capricious.

2. What is Shakespeare's teaching in that simple 'Nothing' of Cordelia?

'That there are some things which a father has no right to compel—things which cannot be forced, or bribed, or bought. Cordelia would have been false to her holiest nature, false to her deep love, if she had allowed her voice to join in a chorus of blatant lies, if she had offered her affection in exchange for the royal bribe.'

3. Victor Hugo says of Gonerel and Regan that Shakespeare makes a monster ingratitude, and gives it two heads.

4. 'In "Macbeth" the powers of evil are symbolised in the witches, but here the devouring egoism of self-will is the principle dramatically represented in these two furies.

'The storm is the outward and visible sign of the inward and spiritual chaos brought about by passion and sin. It is the instrument chosen for the subjugation of pride and self-will into shame and penitence.'

5. The central point of the play is the purification of the character of Lear under the persecution of his daughters.

Lear is the very personation of unlimited despotism, lawless and selfish. He is surrounded by courtiers, but he does not allow them to be counsellors.

Self-willed, irritable, despotic, rash in temper, weak in judgment. The ruins of a noble nature covered with the weeds luxuriating in habits of tyranny.

At beginning selfish, irritable, foolish, petulant, despotic, unnatural.

At end chastened, quiet, simple resignation in his dying remark.

6. *Cordelia.*—Mrs. Jamieson: 'Everything in her seems to be beyond our view, and affects us in a manner which we feel rather than perceive.'

She appears but little, yet dominates the play.

Act I., 43 lines.
Not again until Act IV., in Scene 4, 24 lines.
,, 7, 37 ,,
,, V., 5 ,,

Sir Stafford Northcote said, 'One of the greatest instances of silence; her beauty consists largely in her silence.'

Moberly says, 'Cordelia's character appears to embody his conception of the ideal Englishwoman, whose faithfulness, strong will, and transparent candour combine with her "gentle and low voice" and the steadfast peace which is ever present with her, to make a character such as the mind of man never imagined before or since.'

Notes on the Selections from Tennyson.

The following notes are taken from Stopford A. Brooke's Tennyson. (Isbister.)

'"The Recollections of the Arabian Nights" is another of these landscape poems. Every verse is a picture of a new reach of the river Tigris; the sound of every word is studied in them, so that the words in their varied sound should do the same office for the poetry that the various tones of colour do for a painting. And to accomplish this the better, he now invented, but far too much and with a luxuriance which he afterwards pruned away, a number of double adjectives, chosen as much for their sound as for their images.' (Make a list of these.)

'"The Lady of Shalott" is a pleasant piece of play with his readers—simplicity in a mask of mysticism.'

'It was never intended to have any meaning.'

'The poem grew without intention, like a flower which had not been on earth before.'

'The Lotos Eaters.'—'The landscape is invented.'

'Such invented landscape is sometimes done from a previous study from Nature which is worked up afterwards into a picture, and of this the landscape in the "Ænone," of 1833, is an instance. At other times, it is a picture composed out of various impressions of diverse places brought together into one landscape.

'It is sometimes used to illustrate the human passions treated of in the poem, the landscape echoing as it were the feelings of the persons, even the progress of their thoughts.

'Tennyson does it with great deliberation in "The Lotos Eaters."'

'The main thought of the poem is of great simplicity, and its feelings felt at all times of human life.

"Oh, rest ye, brother mariners, we will not wander more."

'The first sketch of this thought was in the "Sea Fairies," of 1830.

'Then that was made into "The Lotos Eaters," of 1833.

The poem was recast in 1842, and there was added the passage:—

'Dear is the memory of our wedded lives,' &c.

'which doubles the human interest of the poem; and, secondly, instead of the jingling, unintellectual, merely fanciful ending of the poem of 1833, every image of which wanders hither and thither without clear purpose, and weakens the impression of the previous part, the poem thus closing in a feeble anti-climax, we have the weighty, solemn, thoughtful, classic close, embodying the Epicurean conception of the gods, bringing all Olympus down into harmony with the indifferent dreaming of the Lotos-eaters, but leaving in our minds the sense of a dreadful woe tending on those who dream.'

'The style of "Dora," in relation to its subject, is concise to a fault—so concise that it forces us to think of it as much as of the story.'

'Moreover, this extreme brevity of representation is quite unlike the way in which life is conducted by the class of which he writes. The men and women of this class live a delayed life. When their doings and sayings are so condensely given as they are in "Dora," we are taken out of their atmosphere.'

Referring to "Ulysses and Tithonus," Brooke says:—

'That poem ("Ulysses") was built out of his own character, and embodied a type with which he had the strongest sympathy.'

'I suppose from internal evidence that this poem, published in 1860, was written not very long after the "Ulysses." It has the same atmosphere of youthful feeling and the same technical maturity.' 'Nothing of its kind approaches it in modern poetry, nor anything in which the imagination of Tennyson is at work with greater creativeness, insight, pathetic power, passion, noble sensuousness, and simplicity.'

On 'The Brook,' Mr. Stopford Brooke says:—

'No poem is this class is more graceful. It also is in a new style. Only a double-natured man like Tennyson, delicate and rugged, could have written it.'

'Tennyson issued his Ode on the day of Wellington's burial, and republished it a year after with many notable changes.'

Mr. Brooke expresses the wish that division VII. of the poem were excluded, for he says:—

'It is too exclusively English, too controversial, too much an attack on France, too contemptuous of the people, whom he sees only as the mob; too fond of the force of great men to the exclusion of the force of the collective movements of the nation.'

'The conduct of the piece is excellent. It swells upward in fuller harmony and growing thought till it reaches its climax in the division (VI.) about Nelson and Wellington. Then it slowly passes downwards in solemn strains like a storm dying in the sky, and at the end closes in soft spiritual passages of ethereal sound, like the lovely clouds about the setting sun, when the peace of evening has fallen on a tempestuous day.'

'That ringing and high-angered ballad—"The fight of the *Revenge*."'

'The soul of the Elizabethan age, and of its great adventures, its hatred of Spain, its bold sea-captains who laughed the impossible to scorn, even the very ballad music of the time, inform that ballad, which dashes along like the racing billows of the sea.'

'The *Revenge* herself is alive and does not desire to live when she has an alien crew.

'And the great ocean and the sky feel with the ship—they, too, are English; no English boat, they think, shall belong to Spain—and they bury the *Revenge* in the fathomless main by the island crags.'

'To compare the first draft of the "Ænone" with the second, is not only to receive a useful lesson in the art of poetry—it is also to understand, far better than by any analysis of his life, a great part of Tennyson's character; his impatience for perfection, his steadiness in pursuit of it, his power of taking pains, the long intellectual consideration he gave to matters which originated in the emotions, his love of balancing this and that form of his thought against one another, and, when the balancing was done, the unchangeableness of his acceptance of one form, and of his rejection of another; and finally, correlative with these qualities, his want of impulse and rush in song, as in life—English, not Celtic, at all.'

'The Palace of Art' 'marks the first rising in his mind of thought on the graver questions of life; not thought on the world around him, or on any question as it affects humanity, but on a question concerning himself and his duty as an artist.'

'I write,' he says, 'a sort of allegory of a soul that loved beauty only, and good and knowledge only for their beauty; and who shut out Love.'

The characteristics of Tennyson:—

(*a*) Simplicity coming directly from his character.
(*b*) Clearness—
  (1) In thought.
  (2) In expression.
  (3) In representation.
(*c*) Equality of effort.
(*d*) Conscious egotism of his work as a poet.
(*e*) Christian in the sense of God's Fatherhood, man's brotherhood, love as the absolute life of God and of man, personal immortality in God, the forgiveness of sin.
(*f*) Intensely patriotic, never international.
(*g*) Oligarchical as opposed to democratic.

Thirteen Weeks' Work in S.M. First Year.

The references are to Gladman's 'School Work,' which, though diffuse, covers completely all the syllabus.

I. General Principles—What they are and how arrived at—Empirical and Philosophical Methods—Use and Limitation of a Knowledge of Principles.

Special Methods—Reading—The Qualities of Good Reading—The Alphabetical, Phonic, and Look and Say Methods of Teaching. (i. 167–180.)

II. Principles concerning Environment and Educative Influences—Development of Faculty by Exercise—Self-development—Heredity. (ii. 88–97.)

Reading—Teaching the Alphabet—How to Conduct a Lesson to Juniors, and to Seniors—Code Regulations concerning Reading and Reading Books. (i. 181–189.)

III. Spencer's Guiding Principles Explained and Illustrated. (ii. 98–101.)

Spelling, Its Difficulty—Methods of Teaching and Testing Spelling—How to Conduct a Dictation Lesson. (i. 191–200.)

IV. Lesson-giving—Marks of a Good Lesson—Common Faults—How to Criticise. (i. 157–161.)

Arithmetic, Its Importance—First Notions of Number—Notation—Addition—Subtraction—Concrete Illustration. (i. 219–240.)

V. Methods of Teaching Generally—Telling and Eliciting—Illustration and Explanation—Comparison and Contrast—Repetition, Importance of—Synthetic and Analytic Methods. (i. 109–128.)

Multiplication and Division—How to Teach and Explain the Rules. (i. 241–246.)

VI. Compound Rules, How to Explain and Teach the Tables—Visible and Tangible Illustrations—Reduction, &c. (i. 247–249.)
Interrogation—Questions Classified according to their purpose—The Art of Questioning, and of Dealing with Answers—Definition. (i. 137–147.)

VII. Education Values, the Science of—The Elementary and Class Subjects, their Value as Knowledge and as Discipline—Their Order of Importance.
Practice and the Method of Unity—Method of Procedure in each case.

VIII. Infant Instruction, Principles of—Importance of the Concrete—Power of Attention in Infants—Consequent Length of Lessons, and Changes of Employment—Code Requirements for Infant Schools.
Vulgar Fractions—First Principles—How Presented to the Eye—G.C.M. and L.C.M.—Addition and Subtraction Illustrated. (i. 252, 253.)

IX. Frobel and the Kindergarten—Varied and Appropriate Occupations—Importance of Eye and Hand Training. (C. iv.)
Vulgar Fractions—Explanation and Illustration of Multiplication and Division, &c. (i. 253–254.)

X. Elementary Science, Value of—How to Teach—Continuation of Object Lessons—Courses Suggested in the Code.
Decimals—Notation—Simple Rules—Recurring Decimals—Reduction to Vulgar Fractions.

XI. Drawing, Its Value and Importance—Spencer's Views on Teaching Drawing—Course Prescribed by S. and A. Department.
Proportion, Simple and Compound—Interest—Percentages, &c.

XII. Geography—Code Requirements—How to Teach, and Apparatus Required for the Course for Standards I. and II. (i. 260–276.)
History—Value of—Kind of History to be Taught—Purpose of Teaching History—Code Requirements. (i. 277–289.)

XIII. Grammar—Code Requirements—Alternative Courses—Inductive and Deductive Methods of Teaching—Analysis and Composition. (i. 288–306.)
Writing—Characteristics of Good Handwriting—Methods of Teaching—Mulhauser's—Locke's—Jackson's—Position of Scholar—Drill, &c. (i. 202–218.)

Fifteen Weeks' Work in Theory of Tonic Sol-Fa (First Year).

The references are to the Standard Course (Curwen).

1. Production of Tone and Classification of Voices.

2. Key-tone and Dominant 3—Accent, Pulse, Measure 6—Ear Tests 12—Hand Signs iv.

3. Mediant 4—Chord of Tonic 4—Mental Effects 4—Half Pulses 7.

4. Super-tonic and Leading-note 15—Taa-tai-ing 7—Medium Accent 18.

5. Chord of Dominant 20—Different kinds of Measure 18—Silent Pulses 18.

6. Subdominant and Submediant 26—Quarter Pulses 18—Time Hand Signs v.

7. Chord of Subdominant—Qualifying of Mental Effect 28—Intervals of Scale 48.

8. Major and Minor Seconds and Thirds 21—Unequal Divisions of a Pulse 34—Pointing from Memory 12—Writing Notation very Boldly and Legibly—Summary of Steps 1, 2, 3.

9. Fourth Step—Transition by Imperfect Method 49—Ear Tests in Transition.

10. Inversion of Seconds and Thirds 21—Pitching Tunes 29—The Metronome 33.

11. Intervals of Fourths and Fifths perfect, &c., 21—Moving of Doh, and New Tone—Musical Terms 163, 164.

12. Inversion of all Intervals—Transition by Better or Perfect Method 50.

13. Doubling or Halving Time Values—Cadence or Passing Transition 52.

14. Intermediate Rhythms—Signature of Transition by Key-name, New Tone, and Bridge-note 51—Six Pulse Measure 24.

15. Beating Time 86—Changing Major Intervals into Minor, and *vice-versa*—Writing Exercises for Code.

Fourteen Weeks' Work in General Geography.

1.	Brook,	pages	34–43, 157–174.
2.	,,	,,	43–51, 340–354.
3.	,,	,,	51–58, 354–364.
4.	,,	,,	58–66, 365–374.
5.	,,	,,	66–68, 375–386.
6.	,,	,,	68–70, 386–397.
7.	,,	,,	71–78, 397–409.
8.	,,	,,	79–89, 409–417.
9.	,,	,,	89–101, 417–429.
10.	,,	,,	101–116, 429–441.
11.	,,	,,	116–126, 227–233.
12.	,,	,,	126–134, 175–191.
13.	,,	,,	134–145, 191–201.
14.	,,	,,	145–157, 202–209.

Thirteen Weeks' Work in the History Period.

Mr. Cusack has published a Text Book specially for the Period.

I. Grenville Ministry—Peninsular War—The situation on the Accession of George III.

II. North's Ministry—Austrian War, 1809—Letters of Junius—Provisions of Act of Union.

III. North-Fox Coalition Ministry—Russian War, 1812—Partition of Poland.

IV. American War of Independence—War of Liberation—Gordon Riots—Provisions of Treaty of Versailles, 1783.

V. Pitt's Ministry—Hundred Days—Grattan.

VI. Rockingham's Ministry (2)—Congress of Vienna—Washington—Wellington.

VII. Development of English Rule in India—Domestic Reforms, 1789–1820—Siege of Gibraltar—Nelson.

VIII. Ireland—The Literature of the Period—Clive and Fox.

IX. The French Revolution—India, 1789–1820—Dundas Bill.

X. The First Coalition—Ireland, 1789–1820—Hastings.

XI. The Second Coalition—Trade and Commerce of the Period—Burke.

XII. The Third Coalition—Bute—Ireland and the Union.

XIII. The Fourth Coalition—Wilkes—Bonaparte—Provisions of Treaty of Paris, 1763.

Eleven Weeks' Work in S.M. Second Year.

The references are to Cartwright and Gladman.

I. Discipline—Importance—Motives to be utilised—Aims and Methods. (i. 37.) Cart., chap. vii.

II. Rewards and Punishments. (i. 70–90.) C., viii.

III. Lighting and Warming Rooms. C., x.

IV. Formation of Habits and Character. C., ix. and xi.

V. Health—Eyesight in School—Infectious Diseases and Precautions concerning them. C., xii.

VI. Organization, Systems of—Staff and Staffing. (ii. 36–44, and Code.) C., xiii.

VII. Classification of Scholars—Importance of—Methods of. (ii. 36–44, and Code.) C., xiv.

VIII. T.T.'s—Principles involved—Circumstances affecting—How to Draw up a T.T. (ii. 45–54.) C., xv.

IX. School Furniture—Construction and Mode of Arrangement. (ii. 66–74.) C., xviii.

X. Apparatus for Ordinary Subjects—For Object Lessons—Cabinet of Objects. C., xix. 172–185.

XI. Rooms—Size—Shape—Space per Scholar—Ventilation. C., xix. 186–195.

Fourteen Weeks' Work in Theory of Tonic Sol-Fa (Second Year).

1. The Modes 84—Fifth Step.

2. Voice Production 1, 2—Modern Minor Mode 86.

3. Compass of S. A. T. and B Voices 29—The three forms of the Minor or Lah Mode.

4. Tonic, Dominant, Leading-note, &c., of the Minor Mode 86.

5. Changing Minor Intervals into Diminished—Beating Time 86—Syncopation 34.

6. Shorter Compass of Children's Voices—Rare Accidentals 88.

7. Changing Major Intervals into Augmented.

8. Fah and Se essential 6th and 7th of Minor Mode as in second form—Signature of Transition 51.

9. Changing Major Passages into Minor, and *vice-versa*.

10. Causes and Remedies for Flattening 109.

11. Transition of Two Removes 117—Registers of Voice 107.

12. Changing Passages from Imperfect to Perfect Method, and *vice-versa*.

13. Cultivation of Upper Register of Boy's Voice downwards from E or F 107.

14. Writing Exercises for Code—Change of Interval with Change of Name Invariable; Thus, f la—f se.

TESTS FOR THE MONTH.

First Year.—Women.

1. Write in text hand and small hand.—

'There is no joy but calm!'

2. Write from dictation :—

Prince Charles's journey to Madrid | had revealed to those around him | the strange mixture of obstinacy and weakness in his character | the duplicity which lavished promises | because it never purposed to be bound by any | the petty pride that subordinated every political consideration to personal vanity or personal pique. | He had granted demand after demand | till the very Spaniards lost faith in his concessions. | With rage in his heart at the failure of his efforts | he had renewed his betrothal on the very eve of his departure | only that he might insult the Infanta by its withdrawal when he was safe at home. | But to England at large the baser features of his character were still unknown. | The stately reserve | the personal dignity and decency of manners | which distinguished the Prince | contrasted favourably with the gabble and indecorum of his father.

3. (*a*) What is a general principle? Explain fully what is meant by the statement: 'Concrete before abstract should be the rule for the teacher.'

(*b*) What are the qualities of good reading in Standard III. and Standard VI. respectively.

(*c*) Describe the phonic method of teaching reading, and discuss its value and defects.

(*d*) What are the marks of a good lesson? Write notes of a lesson on Subtraction.

(*e*) What do you understand by the phrase: 'Development of a faculty by exercise.'

(*f*) What differences do you distinguish between an exercise for reading and one for spelling?

Give some simple rules for a Pupil Teacher giving a dictation exercise.

(*g*) What special mental faculties are called into exercise in the study of the theory and in the practice of Arithmetic. What place would you give to Mental Arithmetic in a scheme of Arithmetic for Standard V.?

(*h*) Explain fully what you understand by 'Attention!'

4. (*a*) Explain fully what is meant by 'nutritive food.' What are the main divisions of nitrogenous food stuffs?

(*b*) Describe the organs of digestion.

(*c*) Discuss the relative values of a 'mixed' or 'separate' diet.

(*d*) Explain *fully* what is meant by 'mastication,' and what is the function of saliva and bile.

(*e*) Describe the position, structure, and function of the liver.

(*f*) What are the essential constituents and the relative value as articles of food, of meat, potatoes, fish, and green vegetables?

(*g*) Into what classes are food stuffs divided? Describe the chief qualities of each class. Classify the following: Cheese, oranges, bread (white and brown), sugar, milk, carrot, cabbage, salt.

(*h*) Describe as fully as you can the food stuffs included in the botanical grasses.

5. (*a*) Give simple directions for making a button hole and stitching on a button.

(*b*) Discuss the relative value of lessons in cutting out and needlework, and indicate the amount of time for each you would allow in each standard.

(*c*) Give directions, with diagrams, for cutting out an infant's shirt.

(*d*) What stitches would be required in making a woman's chemise? Describe, as to a class, with diagrams any two of these.

(*e*) Draw a diagram of a woman's chemise ($\frac{1}{4}$-inch scale). Give directions for making up the garment.

(*f*) Set in a triangular flannel patch and darn on it as for a thin place.

(*g*) On the piece of calico enclosed (6 × 6), show not less than three inches of the following stitches:—Hemming, sewing, stitching, and feather stitching.

(*h*) Cut out and make up an infant's first shirt (lined paper).

6. (*a*) Describe the mental effects of me, fah, te, la, doh.

(*b*) What other four contiguous tones of the scale are separated by the same steps, or intervals, as:

(1) **s l t d'**

(2) **l_1 t_1 d r**

(*c*) Name the following intervals:—

m—d_1, r—s, t_1—l, f—t, t_1—s, m—t, ta—r

(*d*) Which of the following is highest in pitch?

(1) t_1 in Key C.
(2) r in Key A.
(3) s in Key D.
(4) f in Key B♭.

(*e*) Fill up two measures of each of the following kinds, showing half-pulse notes, continuations, and rests in each example. Vary the contents of the measures in each time :—

(1) Two-pulse measure.
(2) Four-pulse measure.
(3) Three-pulse measure.

(*f*) Write two measures in six-pulse measure and three-pulse measure, showing half notes and dotted notes, and give the time names for each pulse.

(*g*) Re-arrange in order of pitch, placing the highest note first in each case.

(1) **s d fe l t' d' m ta r' f r m'**

(2) **d s' r f' fe ta m l' s d'**

(*h*) Write figures over the following to indicate the value of each note and rest :—

s :.l, s	**f .m :r.**	**m,d :f**	**m :**
r : — | — :r,m.f		**s : — | —. :**	

N.B.—Paraphrase is omitted from the syllabus.

7. (*a*) Write essays on the following subjects :—

(1) Tennyson's 'Dora.'
(2) A Storm.
(3) The Sea and its Wonders.
(4) Distinction between a Trade and a Profession.

(*b*) Parse the following words (Tennyson) :—

'Arabian Nights' :—Line 1, free; 20, goodly, sooth; 6, borne; 45, still onward; 46, as; 49, low; 71, Nothe; 80, unwoo'd; 86, dark; 111, unawares; 115, right; 118, ran; 123, as, quintessence; 145, pure silver.

'L. of S.' :—1, river; 21, unhail'd; 22, silken-sailed; 23, skimming; 29, drawing; 39, whisper, say; 87, slung; 98, trailing light; 136, lying.

'Lotus-Eaters' :—1, courage; 2, roll; 5, did; 13, rolling; 17, dew'd; 21, down; 22, border'd; 34, as voices; 51, eyelids; 59, else; 60, alone; 61, only; 63, thrown; 68, there, calm; 99, hearing; 101, falling asleep; 125, remain; 155, careless; 158, girdled; 163, steaming up, lamentation, tale; 165, chanted.

'Dora' :—14, to; 32, more; 44, being meek; 45, It cannot be; 49, heart-broken; 50, what; 51, them; 57, now; 60, that's; 74, Dare; 143, his marrying; 148, that.

(*c*) Analyse 'A.N.' Lines 100 to 110.
,, 'L. of S.' ,, 103 ,, 171.
,, 'L.-E.' ,, 84 ,, 89.
,, ,, ,, 114 ,, 119.
,, 'Dora' ,, 78 ,, 82.
,, ,, ,, 112 ,, 116.

(*d*) (1) Compare Tennyson's 'Dora' with Miss Mitford's account, and compare with Wordsworth's 'Michael.'

(2) Describe the materials from which the 'Lotus-Eaters' is drawn, and your conception of Tennyson's object in the poem.

(3) Explain the allusions in or the use of the following words and phrases :—Sheeny, Haroun Alraschid, aught, clove, platans, sluiced, clomb, engrained, tiars, bulbul, counterchanged, chequered, unawares, Pavilion of the Caliphat, diapered, mooned domes, many-towered, melons whiten, Galaxy, blazoned, baldric, rung, slow-dropping, galingale, urn of brass, amaranth, acanthus, foam fountains, asphodel.

(4) Discuss, with examples, the following description of the 'Recollections' :—

'This is another of these landscape pc**ems.'**

8. (*A*) (*a*) How may it be determined by measurement that the earth is not spherical? Why is the solar day an unfit measure of time? What is the mean solar day?

(*b*) Explain why in the belt between the tropics the sun appears vertical in the sky twice in a year. Why does not an accurate clock always indicate twelve when the sun is on the meridian? Why are three of the leap years common years in each cycle of 400 years.

(*c*) What are the principal motions of the earth? Explain how it is that varying seasons and days and nights of unequal duration are caused by the plane of the equator being inclined to the ecliptic.

(*d*) Comment fully on the following statement :—

'The earth is borne along in the heavens by various movements far more numerous and peculiar than most people would be inclined to suppose.'

(*e*) Explain carefully how the seasons are caused, and give the exact meaning of the terms Equinox, Tropic, Solstice.

(*f*) A complete movement of rotation performed by the globe round its own axis does not exactly coincide with the solar day. Why? What is a 'sidereal day'?

(*g*) Explain fully why all places lying in the same latitude have equal length of day and night, while all places in the same longitude have mid-day at the same time, and show why the frigid zones are for a certain period of the year involved in continual night or continual day.

(*B*) (*a*) Give an account of the rise, progress, and present state of the woollen and iron manufactures of Great Britain.

(*b*) Whence do we obtain our chief supplies of corn, dried fruit, raw cotton, silk, timber, wine.

(*c*) Name two towns in the British Isles noted for each of the following manufactures, and the river, if any, on which they are respectively situated:—

Wool, glass, salt, silk, carpets, hosiery, lace, linen, woollen tartan.

(*d*) Whence do we obtain maize, quinine, rice, diamonds, hides, jute, ostrich feathers, teak, wool.

(*e*) Draw a sketch map of the Irish Sea.

(*f*) Write an account of the Mediterranean Sea under the heads :—

(1) Physical divisions.
(2) Fisheries.
(3) River system.
(4) Commerce.

9. (*A*) (*a*) Sketch the careers of one English statesman, one English admiral, and one English soldier who figured conspicuously in the European struggle which arose out of the French Revolution.

(*b*) Give an account of the rise and growth of the East India Company.

(*c*) Sketch the condition of Ireland during the reign of George III.

(*d*) Explain clearly the leading causes of the separation of the American colonies from England, and fix the leading events of the war.

(*e*) Give an account of the Grenville Ministry, its composition and actions.

(*f*) Write a short essay on the political and social situation at the accession of George III.

(*g*) Make a table of the principal events of the Peninsular War and describe in detail the lines of Torres Vedras.

(*B*) (*a*) Prove the rule for dividing a fraction by a whole number.

(*b*) Define notation, ratio, proportion, complex fraction, simple interest.

(*c*) Find, by practice, the cost of 7 tons 3 cwt. 2 qrs. 19 lbs. of iron wire at £16 6s. 8d. per ton.

(*d*) If 713 ac. 3 rds. 39 pls. be let for £1,903 19s. 8d., find the rent (at the same rate) of 8 ac. 3 rds.

(*e*) Divide 750,507 by 132 by factors, and explain carefully, as to a class, how the remainder is obtained.

(*f*) By what fraction of a ton is $(\frac{3}{7} + \frac{8}{10})$ of a cwt. greater than $\frac{2}{3}$ of $\frac{3}{5}$ of a qr.?

(*g*) Simplify $\dfrac{\frac{3}{4} - \frac{1}{2}}{5 - \frac{3}{8} \text{ of } \frac{24}{30}} \div \dfrac{\frac{1}{6} \text{ of } \frac{7}{10\frac{1}{2}}}{1\frac{2}{3} + \frac{1}{2}}$, and explain, as to a class, the mistake in

$$\tfrac{2}{3} + \tfrac{1}{4} \text{ of } \tfrac{2}{3} - \tfrac{2}{3} = \frac{8+3}{12} \times \frac{20-9}{24} = \tfrac{11}{12} \times \tfrac{11}{24} = \tfrac{121}{288}.$$

(*h*) 19,332 miles of railway earned in one year £66,615,377. Find, in pounds only, the receipts per mile. How would you show Standard III. children the approximate answer to be expected to such a problem?

(*i*) Express as the fraction of a ton $\frac{2}{3}$ of $\frac{3}{4}$ of a cwt. + $\frac{8}{10}$ of 15 cwt. 3 qrs. — 3 cwt. 2 qrs. 14 lbs.

(*j*) What sum must be added to $\frac{9}{10}$ of $\frac{11}{12}$ of $\frac{5}{7}$ of £2 to make up 10s.

FIRST YEAR.—MEN.

From 1 to 9 inclusive, as Women.

10. (*a*) How would you briefly explain the rule for dividing one vulgar fraction by another?

(*b*) If $\frac{11}{13}$ of $\frac{13}{35}$ of 2s. $1\frac{1}{2}$d. be taken from $\frac{3}{7}$ of $\frac{21}{22}$ of 7s. 4d., what fraction of 17s. 8d. will remain?

(*c*) Simplify $\dfrac{2\frac{1}{2} - 1\frac{1}{3} \text{ of } 2\frac{1}{4} + 1\frac{7}{10}}{(2\frac{1}{2} - 1\frac{1}{3}) \text{ of } (2\frac{1}{4} + 1\frac{7}{10})}$ of $\dfrac{\frac{3}{11} + \frac{3}{7}}{\frac{4}{7} - \frac{3}{11}}$.

(*d*) The sides of a rectangular vessel are 11 ft. 11 in., 13 ft. 9 in., and 16 ft. 3 in. respectively. Find the side of a cubical vessel of equal volume.

(*e*) Explain the rules for mental solutions of—

(1) To multiply by 625.
(2) Price of any number of things at 2s. 1d. each.
(3) Simple Interest at $6\frac{3}{4}$% per annum.
(4) Difference of squares of two consecutive numbers.

(*f*) At a game of skill A can give B 20 in 100, B can give C 15 in 100. How many can A give C?

(*g*) Find the square root of $7\frac{707281}{848356}$.

(*h*) Find the value of $\dfrac{18{\cdot}7}{{\cdot}204}$ of £2 12s. $-\dfrac{{\cdot}94}{{\cdot}083}$ of £16 12s., and express the result as a decimal of £890.

11. (*a*) Find the value of

$$(a-c)^2 - (3b - c^2) + \sqrt{(a-c)(b-d)}.$$

(*b*) If c be a common measure of a and b it will also measure $ma \pm nb$. Find the H.C.F. of $16x^4 - 53x^2 + 45x + 6$ and $8x^4 - 30x^3 + 31x^2 - 12$.

(*c*) Solve the equations—

(1) $\dfrac{7x-9}{20} - \dfrac{9x-7}{14} = \dfrac{5x-3}{16} - 4.$

(2) $17x^2 + 19x - 1848 = 0.$

(*d*) Two parallel chords are drawn on the same side of the centre of a circle whose radius is 96 ft.: one chord subtends an angle of 60° at the centre, and the other an angle of 90°. Find the area of the zone between the chords.

(*e*) Resolve into factors—

$x^2 - 14x - 51$, $x^3 - 729$, $(x+a)^4 - (x-a)^4$,

and prove that

$$a^3(b-c) + b^3(c-a) + c^3(a-b) = (a+b+c)\{a^2(b-c) + b^2(c-a) + c^2(a-b)\}.$$

(*f*) Find the square root of—

$16x^6 - 24x^5 + 33x^4 - 50x^3 + 33x^2 - 24x + 16$,

and prove that

$$\left(\frac{2a}{a-b} - 1\right)^2 + (1-b^2)\left\{\left(\frac{2}{a-b}\right)^2 - 1\right\} \text{ is a square.}$$

(*g*) A number (n) is divided into three parts such that one-third of the number exceeds the first part as much as the second part exceeds one-fourth of the number. Find the third part.

12. (*a*) Define plane, superficies, figure, parallelogram. Distinguish between axioms and postulates.

(*b*) Prove Euclid I. 4.

If two quadrilaterals have three sides of the one equal respectively to three sides of the other, and likewise the angles contained by the equal sides equal in each, the figures shall be equal in every respect.

(*c*) To draw a straight line at right angles to a given straight line from a given point in the same. State the corollary. In what respects is the proof of it not perfectly sound?

(*d*) From a given point to draw a straight line equal to a given straight line. When the given point is neither in the given line nor in it produced, in what different ways may the straight line be drawn?

(*e*) If two angles of a triangle be equal to one another, the sides also which subtend or are opposite to the equal angles shall be equal to one another.

(*f*) If a triangle PQR be turned over about its side PQ, show that the line joining the two positions of R is perpendicular to PQ. (Don't go beyond Euclid I. 4.)

(*g*) To draw a straight line perpendicular to a given straight line of an unlimited length from a given point without it.

From a given point draw a straight line making equal angles with two given straight lines.

(*h*) Define a plane rectilineal angle, a right angle, an obtuse angle, a triangle, an isosceles triangle.

From a given point in a straight lines draw a straight line equal to the given straight line.

SECOND YEAR.—WOMEN.

1. As in First Year.

2. As in First Year.

3. (*a*) What are the processes of thought involved in—
   (1) Classification of objects,
   (2) The use of an abstract noun,
   (3) The use of a syllogism?

(*b*) What is understood by a term, a proposition, a premiss, a conclusion, and a syllogism? Give examples of each.

(*c*) 'A *generic* term *denotes* a larger number of objects than a *specific* term; but *connotes* a smaller number of attributes.' Explain fully this statement, with examples.

(*d*) Distinguish carefully, with examples—
A singular term, a general name, a collective name, positive, negative, and privative as used in logic.

(*e*) Comment fully, with an outline of the sort of lessons and other agencies you would adopt to carry out the statement that 'Discipline is the art by which a right influence is exercised on the manners, conduct, and character of children.'

(*f*) Describe the best devices you know for warming a set of rooms and a hall.

(*g*) What do you understand by rewards and punishment? What kinds of reward appear to you to be legitimate, and what kinds are open to objection, and of what kind?

(*h*) What facts should be recorded in the Admission Register, and in what circumstances may a name be removed from it, or be inserted in it a second time?

4. (*a*) What difference should be made in the way of stewing meat which is meant to be eaten, as distinguished from that intended to make soup? Give your reasons.

(*b*) Describe fully the process of making bread.

(*c*) Give recipes for making—
   (1) Beef tea,
   (2) Mutton broth,
   (3) Pea soup.

(*d*) Suppose the managers of an elementary school intend to establish a cookery class; what sort of room and what apparatus would you advise them to procure? Sketch the first six lessons.

(*e*) Explain these terms:—Phosphate, cereal, albumen, leguminous, fibrin, and caseine, and give examples of their use.

(*f*) What are the tests by which you would judge of the goodness of eggs, bacon, fish? What kinds of fish are most wholesome and economical?

(*g*) Compare the values of beef, mutton, veal, poultry, and fish under the heads of nutrition and economy.

(*h*) Point out some of the common faults of waste and ignorance in English cookery.

5. (*a*) Draw a diagram of a boy's shirt, showing the various parts of the garment. Give directions for making it up.

(*b*) Make and stitch a band of calico, and make and set on a muslin frill.

(*c*) If you allot four hours a week to the teaching of needlework, say how the time is best distributed, with your reasons.

(*d*) On the material supplied show the following stitches:—Sewing and felling, gathering, stroking and setting in, making a button-hole, and sewing on a button.

6. (*a*) Write descending minor scales, Lah mode, (*a*) once with the minor or flat seventh and the minor or essential sixth, and (*b*) once with the major seventh and the minor or essential sixth.

(*b*) Write against each of the following intervals its name:—
   (1) ma—de'
   (2) fah—se
   (3) ta—soh'
   (4) fe—ma'

(*c*) What is the name (1) for *ray* sharp, (2) for *te* flat, (3) *soh* sharp? State what the singer is told to do at ^{d}s in the following passage:—

Key C. f F

s l r m $^{d}s_{,}$ $l_{,}$ $t_{,}$ r d

(*d*) Re-write the following, doubling the value of each note and rest:—

| s, l. s, f : m.,f | s. r, m : d. ‖

(*e*) Write down the names of the tones of the common scale in the order they are taught on the T.S.F. method.

(*f*) Write the following intervals:—
   (1) Above *doh* an augmented fourth.
   (2) ,, *me* a major sixth.
   (3) ,, *doh* a minor sixth.

(*g*) Re-write the following in the 'first sharp' key:—

l fe r s fe d' t l s fe m re m

(*h*) Write three measures, showing rests, continued notes, half and quarter notes, of three pulse, four pulse, and six pulse time.

(7) Write essays on the following:—

(*a*) 'Truth's a dog must to kennel.'

(*b*) 'Striving to better often mar what's well.'

(*c*) The plot, and the source of it, of 'King Lear.'

(*d*) Skating.

(*e*) Parse the following words:—

Essay I. line 2, be that; (6) which; (9) finding; (10) that doth; (25) imaginations as one would; (28) one; (32) of before; (49) thereof; (51) always.

Essay II. (7) shall read; (18) terrible.

Essay IV. (1) more; (2) for as; (5) taking; (12) himself; (26) arrow.

Essay V. (36) certainly.

'Lear,' Act 1, Scene 1, (27) shall; (29) me, know; (30) three; (33) unburthened; (41) us; (48) space; (59) be, perpetual; (61) sister; (68) Cordelia; (69) And yet not so; (72) Remain; (102) night; (137) be; (138) man; (213) monsters; (242) being poor.

Act 1, Scene 2, (80) mistaking; (115) honesty; (136) dissolutions.

Act 1, Scene 4, (209) which; (211) that; (216) darkling.

(*f*) Analyse—

Essay I.—'To pass . . . embaseth it.'
,, II.—'He that dies . . . expectations.'
,, IV.—'You shall read . . . in a proportion.'
,, V.—'Certainly virtue . . . virtue.'

'King Lear,' Act 1, Scene 1.—'Good, my lord . . . To love my father all.'
,, ,, ,, —'I yet beseech your majesty . . . Hath lost me in your liking.'
,, ,, Scene 2.—'This is the excellent foppery . . . divine thrusting on.'
,, ,, Scene 4.—'I do profess . . . and to eat no fish.'
,, ,, ,, —'Mark it, nuncle . . . to a score.'
,, Act 2, Scene 2.—'Such smiling rogues . . . epileptic visage.'

(*g*) Comment on: 'The urne of devils,' mummery, sects of philosophers, one of the later schools, the poet, poles of truth, worthy the observing, obsequies, canticle, *pompa mortis*, Livia, etc., Stoics, things present and to come, Cosmus, Pertinax, is not without, poesy, hearse, Hercules, Prometheus.

(*h*) Comment on: Affected, brazen, sennet, champains, felicitate, and well are worth the wrath that you have wanted, treachers, nuncle, Lady the brach, darkling, the sea-monster, the seven stars, where Nature doth with merit challenge, the most precious square of sense, set my rest, upon the gad, spherical predominance, you were best, kibes, mumbling.

(*i*) (1) Write an analysis of the essays on Truth and Revenge.
(2) Write a sketch of the character of Lear.

8 and 9. As First Year.

10. (*a*) Explain what is meant by cancelling. In what arithmetical processes is it useful, and give examples.

(*b*) Reduce these fractions to a common denominator, and explain the reason of the process, $\frac{2}{13}$, $\frac{4}{15}$, $3\frac{7}{10}$, $\cdot 17$, $\frac{5}{8}$.

(*c*) Give, with examples, rules for shortening the following processes:—

(1) Multiplying by 99, 25, 246.
(2) Squaring a number.
(3) Finding interest for years and months at 2½ per cent.

(*d*) Find the L.C.M. of 20, 12, 15, 18, 4, and the H.C.F. of 702, 1368, 1944.

(*e*) By ordering coal direct from the pit, I obtain 21 cwt. to the ton. What quantity must I order to save 15s. when the price is 25s. per ton?

(*f*) If one number measures two others, it will measure the sum or difference of any multiples of them. Show, as to a class, using both letters and numbers, the truth of this statement.

(*g*) If I subtract from any number the same digits in another order, I get a remainder which is made up of nines. Explain the reason of this as to a class.

(*h*) If our base of notation were *six* instead of ten, how would the number 375 be expressed? Prove your answer, and write the numbers from one to fifty in the scale of six.

(*i*) Find to five decimals the difference between the square of 8·50163 and the cube of 3·712.

(*k*) Reduce to decimals and add together $\frac{1}{8\frac{1}{7}}$, $\frac{27}{10000}$, $\frac{188}{625}$, and $\frac{221}{5\frac{1}{2}}$.

SECOND YEAR.—MEN.

1–3, 6–9. As Second Year, Women.

ALGEBRA AND MENSURATION.

(*a*) Show that a, b, c, are in arithmetic, geometric, or harmonic progression, according as:—

$$\frac{a-b}{b-c} = \frac{a}{a} \text{ or } \frac{a}{b} \text{ or } \frac{a}{c}.$$

If a, b, c, d, are in G.P. $(a-d)^2 = (b-c)^2 + (c-a)^2 + (d-b)^2$.

(*b*) Define ratio, and if

$$\frac{a+c}{b} = \frac{c}{a} = \frac{a}{c-b},$$

determine the ratios $a : b : c$. If the square root of x varies as the cube root of y, and if $x = 64$ when $y = 343$, find the equation between x and y.

(*c*) Solve the equations

(1) $\sqrt{x^2+10x+5} = \sqrt{5x+4} + \sqrt{5x-4}$.

(2) $\begin{cases} 4(x^3+y^3) = a^3 + 3ab^2, \\ x+y = a. \end{cases}$

(*d*) Show that $a^{\frac{1}{n}} \times b^{\frac{1}{n}} = (ab)^{\frac{1}{n}}$. What does a^0 denote? Find the square root of $(x+x^{-1}) - 2\left(x^{\frac{1}{2}} - x^{-\frac{1}{2}}\right) - 1$.

(*e*) Simplify

(1) $\dfrac{x^4+1+(x+1)^4}{\{x^2+1+(x+1)^2\}^2}$;

(2) $\dfrac{e^{x^{-1}} + xy^{-1} + yx^{-1} + e^{y-x}}{xy^{-1}e^{x-x} + 2 + yx^{-1}e^{y-x}}$.

(*f*) Find the number of permutations of n things taken r together. How many different words may be made of the letters of the expression $a^2c^3b^4c$?

(*g*) Solve the equations

(1) $x^4 + 5 - 2\sqrt{x^2+2} = 5x^2$.

(2) $\begin{cases} 2x^2 + 3y^2 - xy = 31, \\ x - y = 3. \end{cases}$

(*h*) Find the edges of a cube whose solidity is equal to that of a rectangular parallelopiped whose edges are 9 ft. 4 in., 21 ft. 4 in., 32 ft. 8 in.

(*i*) Find the radius of a sphere whose volume is 6558·552 cubic feet.

EUCLID.

(*a*) The opposite sides and angles of a parallelogram are equal to one another, and the diameter bisects it—that is, divides it into two equal parts.

If from the base to the sides of an isosceles triangle three lines be drawn, making equal angles with the base, one from its extremity, the other two from any point in it, these two are together equal to the first.

(*b*) To describe a square on a given straight line.

From LN, the diagonal of a square LM. NR, cut off LS equal to one-fourth of LN, and join SM, SR. Show that the figure MLRS equals twice the square on LS.

(*c*) If a straight line be divided into any two parts, the squares on the whole line and on one of the parts are equal to twice the rectangle contained by the whole and that part, together with the square on the other part.

(*d*) Construct a triangle whose sides are equal to three given straight lines, any two of which are together greater than the third.

Show by diagrams what will happen if you attempt to construct triangles whose sides contain units in the following relations:—(1) 2, 3, 4; (2) 2, 3, 5; (3) 2, 3, 6.

(*e*) If a straight line falling on two other straight lines make the alternate angles equal to one another, or make the interior angles on one side together equal to two right angles, these two straight lines shall be parallel.

Show that a four-sided figure which has all its sides equal, and one angle a right angle, is a square.

(*f*) To divide a given straight line into two parts, so that the rectangle contained by the whole and one of the parts may be equal to the square of the other part.

Show how to produce a straight line, so that the rectangle contained by the given line, and the line made up of the given line, and the part produced, may be equal to the square of the part produced.

(*g*) In any acute-angled triangle the squares of the sides containing the acute angle are together greater than the square of the side subtending the acute angle by twice the rectangle contained by one of the sides, and the straight line intercepted between the acute angle and the perpendicular let fall on it from the opposite angle.

The straight line PQ is divided in R, so that the rectangle PQ.QR is equal to the square of PR. Circles with centres Q, R, and radii equal to PR, intersect in S. Show that PQS is an isosceles triangle, having each of the angles PQS, PSQ, double of QPS.

(*h*) The three interior angles of every triangle are together equal to two right angles.

Show how to construct an isosceles triangle whose vertical angle is four times each of the angles at the base.

(*i*) Parallelograms on equal bases, and between the same parallels, are equal to each other.

On one side of an equilateral triangle construct a parallelogram equal to the sum of any parallelograms on the other two sides.

NEW COMPOSITION STORIES.—STANDARD V.

Suitable for 'Unseen Tests' in Reading also.

260.

A SAGACIOUS BIRD.—At a certain country house the pheasants were fed daily from a kind of box, the lid of which rose with the pressure of the bird standing on the rail in front of the trough. A water-hen, observing this, went and stood upon the rail as soon as a pheasant had quitted it; but its weight being insufficient to raise the lid, so as to enable it to get at the corn, the bird kept jumping on the rail to try to open the box. This partially succeeded, but not to the satisfaction of the sagacious bird. Accordingly it went off, and returning with another of its own species, the united weight of the two had the desired effect, and the successful pair enjoyed the reward of their sagacity.

261.

PUNCTUALITY.—Once an old Englishman, James Scott, by name, travelled about on business until he was nearly eighty years of age. He became celebrated for his punctuality and his methodical habits. Upon one occasion a gentleman stopped at an inn much frequented by Mr. Scott, and saw a fine fowl cooking. 'That is very good,' said the hungry guest. 'You may serve that for my dinner.' 'You cannot have that, sir,' replied the landlord. 'That is being cooked for Mr. Scott, of Exeter.' 'I know Mr. Scott

very well,' said the gentleman. 'Is he stopping here?' 'Oh, no, sir,' answered the landlord. 'But six months ago he ordered a fowl to be ready for him at precisely two o'clock to-day, and we are expecting him every minute.' Just as the clock was striking two Mr. Scott was seen (to the astonishment of those who did not know him) jogging quietly into the yard on his old and faithful pony.

262.

SUMMARY JUSTICE.—A rich man had judgment pronounced against him in favour of a poor man. The latter, however, could not obtain payment, and complained to the Governor. Just as he had finished his case, the pasha saw the debtor riding up the street on a beautiful Arab horse. He ordered the poor man to sit down, and calling a messenger, told him to invite the debtor inside. Entering the room, he was surprised at the extreme cordiality of the pasha, who invited him to sit down and take coffee. When he rose to leave, the governor pressed him to remain, and kept him more than an hour, at the end of which time a messenger entered the room and placed a small bag of money before the pasha, who taking the bag from the table, gave it to the rich man, saying, 'This is yours. I have sold your horse, and paid the poor man out of the proceeds—the balance belongs to you.'

263.

ONE WAY OF CATCHING MONKEYS.—The peasants of Algeria have a curious way of catching monkeys. They take a gourd, make a hole in it just big enough for a monkey's paw to go through, and partly fill it with rice. Then they fasten this firmly to a tree in the forest. During the night a prowling monkey discovers the gourd and examines it. He soon finds out there is rice in it, and squeezes his paw through the hole and fills it. But now his paw is too big to come through the little opening. He is too greedy or too silly to let go the rice and pull his paw out, and so he keeps himself a prisoner in this absurd way till the peasant who has set the funny trap comes in the morning and captures him.

264.

PUSS AND THE FOX: A FABLE.—A fox one day said to his friend the wild-cat, 'When the hounds come to hunt for me, I have such tricks to get out of their way that they cannot catch me. I have ten tricks, and ten times ten more than you could guess.' 'As for poor me,' said the cat, 'I have but one, and if that should fail I am a lost cat.' 'Alas, poor puss!' said the fox. Just then they heard the blast of the horn, and up came the hounds in full cry. The fox ran this way and that, and tried all his tricks, but was caught at last. The cat ran up a tree, for that was her one trick, and the hounds could not reach her. 'So I see,' said pussy, 'that one good trick is worth more than all the bad ones.'

265.

THE DUKE AND THE SCHOOL BOY.—The late Duke of Wellington was one day taking his usual country walk when he heard a cry of distress. He walked to the spot, and found a chubby, rosy-faced boy lying on the ground, and bending his head over a tame toad, and crying as if his heart would break. 'What's the matter, my lad?' said the Duke. 'Oh, sir, please, sir, my poor toad—I bring it something to eat every morning. But they are going to send me off ever so far away to school; nobody will bring it anything to eat when I am gone, and I am afraid it will die.' 'Never mind, don't cry, lad—I'll see that the toad is well fed, and you shall hear all about it when you are at school.' The boy thanked the gentleman heartily, dried up his tears, and went home. During the time he was at school he received several letters about his toad, and when he returned for his Christmas holidays, the toad was as the Duke said, 'Alive and well,' but was in his winter's sleep, in which he remained until spring and genial weather brought him from his hole in the ground. The noble Duke had, however, kept his word.

266.

THEIR BEST TREASURES.—Ancient history records that a certain city was besieged, and at length obliged to surrender. In the city there were two brothers, who had, in some way, obliged the conquering general; and in consequence of this, received permission to leave the city before it was set on fire, taking with them as much of their property as each could carry about his person. Accordingly the two generous youths appeared at the gates of the city, one of them carrying their father, and the other their mother.

267.

A PREACHING PARROT.—Some years ago a grocer owned a very valuable parrot, which he always kept in the shop. On one occasion the inspector of weights and measures came in. After examining the weights and thinking them quite right, he was on the point of leaving, when the parrot suddenly cried out: 'Short weights under the counter—short weights under the counter.' The inspector looked, and, to his great surprise, found it true. The grocer in his rage wrung the parrot's neck, and threw it in the pig-sty for dead. After reviving, the parrot looked round, and began questioning the pigs (thinking they had been put there for the same thing): 'Did you say "Short weights under the counter?"' The grocer happened to hear it, and feeling sorry for his cruel conduct, took the bird out and kept it until its death.

268.

SAVED BY A MONKEY.—A little boy was playing in one of the rooms of his father's house with a monkey. The boy, in a joke, tied the cord of a window blind around his neck, and pretended to hang himself, to the immense amusement of his playmate, which grinned and chattered on a chair. Suddenly the boy began to cry, for the cord had got into a real noose around his neck. In a very short space of time the monkey took in the situation, and tried to undo the noose, but had to give up the attempt. It then hopped away to another room, where the boy's grandmother was sitting, and began to pull at her gown, to chatter, and look wistfully towards the door. At first the old lady was frightened, but seeing that he was endeavouring, with might and main, to drag her towards the door, she rose from her seat and went with the monkey to the room where her grandson was moaning. The boy was instantly extricated, though it was some time before he recovered from his pain and fright, and the monkey was rewarded with a cake of chocolate.

269.

A NOBLE OLD FARMER.—In one of the wars in Germany, a captain of cavalry was ordered out on a foraging party. He put himself at the head of his troop, and marched to the quarter assigned him. It was a solitary valley in which hardly any thing but woods could be seen. In the midst of it stood a little cottage: on perceiving it he went up, and knocked at the door; an old man with a beard silvered with age, came out. 'Father,' said the officer, 'show me a field where I can set my troops a foraging.' The good old man walked before, and conducted them out of the valley. After a quarter of an hour's march, they found a fine field of barley: 'This is the very thing we want,' said the captain. 'Have patience for a few minutes,' replied the guide; 'you shall be satisfied.' They went on, and at the distance of about a mile further, they arrived at another field of barley. The troop immediately dismounted, cut down the grain, trussed it up, and re-mounted. The officer then said to his conductor, 'Father, you have given to yourself and us unnecessary trouble; the first field was much better than this.' 'Very true, sir,' replied the good old man, 'but it was not mine.'

270.

TRICKING THE LANDLORD.—A dispute arose between a landlord and his tenant. The latter had given notice to quit, but would not put a bill in his window to say that the house was 'to let.' To make matters worse, they went to law about it. The judge having heard the case, made an order for the defendant to put a bill up within fourteen days. The landlord was so overjoyed at his victory, that on the fourteenth day he took a friend with him round to the house so as to tease his tenant. The bill was up in his window plain enough, but under it was another which ran as follows: 'Leaving through the bad drainage.'

271.

KINDNESS OF SPARROWS.—Several years ago some sparrows built their nests under the roof of a house. One morning, one of the poor little birds fell over the side of the nest, and broke its wing. Several other sparrows came at once to see what was the matter, and seemed to be considering what could be done. At last two of them flew away, and soon returned with a small twig. This they placed under the wounded bird's wing, and taking hold of each end of the twig in their bills, bore their unfortunate companion in safety to its nest.

272.

INTELLIGENCE OF A DOG.—A little girl of about four years of age was some time ago noticed standing on the footpath of a busy street crying. Some passers-by stopped and found that she was lost, but could not discover from the child where she lived. Whilst they were endeavouring to soothe the little one's grief, a large shaggy-haired dog came up, barked loudly with joy, and seized the little one by the dress. The child wiped her eyes in a moment, and hugged the dog, and walked off with him at once. A gentleman followed at a little distance, until he observed both child and dog rush up to a woman. On inquiring, he found that the woman,

having lost her child, had hurried home, and, loosing the dog, said, 'Baby, baby, find her.' The dog had understood, and galloped off, and soon found the child.

273.

TWO CLEVER DOGS.—Once the owner of some rabbits found that night after night, for six nights in succession, one of his pets was stolen from the house which he had contrived for them out of an old wooden case. At the top of it was a small opening, about the width of two hands, which was closed at night by a board on which some large stones were placed. Notwithstanding these precautions, a rabbit was missing each morning; and it was thought that human hands had been at work. One night therefore the owner concealed himself near at hand to watch for the thief. He had not long to wait, for he soon heard a noise at the rabbit-house, and was surprised to see two dogs upon it. One was a very large dog, and the other a small terrier. The big dog at once scratched away the stones and grass and dragged away the board, when the terrier darted into the hutch and brought out a rabbit, which the two companions proceeded to devour. They had evidently come to an understanding by which they helped one another to a supper.

274.

A COURAGEOUS WIFE.—A man, accused of conspiring against the French Republic, was seized and committed to prison. His wife, trembling for his fate, used every means to restore him to liberty, but without success. She then bought, with a sum of money, permission to pay him a single visit in his prison. At the appointed hour she appeared before her husband, clothed in two suits of her own apparel. She hastily took off her upper suit of attire, prevailed upon her husband to put them on and to quit the prison, leaving her in his place. The disguise succeeded to her wish. The man escaped, and the stratagem was not discovered till the succeeding day. 'Unhappy wretch!' cried the governor of the prison when the escape was discovered, 'what have you done?' 'My duty,' she replied; 'now do yours.'

275.

THE FAITHFUL DOG.—A gentleman, when staying at a country inn, took out his purse to pay a small bill, and while doing so, unknowingly dropped a sovereign upon the floor. He left the inn to buy a hat in the neighbouring town, and only discovered his loss in the hatter's shop. On his return to the inn, he was told that there must be something the matter with his dog, that he was behaving very strangely, and that, while he positively refused to eat his dinner, which had been brought to him, he would allow no one to take it away. His master at once went up to the room, and the dog rushed towards him, and dropped a sovereign at his feet. He then ran up to his platter, and devoured his dinner with all the eagerness of a hungry dog.

276.

PAT AND HIS STRAY DONKEY.—An Irishman, having bought six donkeys at a fair, mounted one of them and drove the rest towards his humble home. Before dismounting he counted them, but could only find five. 'The other must have stopped on the road!' exclaimed Pat to himself. He immediately retraced his steps, and drove about everywhere, asking everyone he met if they had seen a stray donkey, until he tired his animal out so badly that it refused to budge another inch, so he had to get off. As he did so he noticed the donkey, and exclaimed: 'What an old stupid I am to be sure! Here have I been looking all over the place for the stray donkey, and by the powers I've been riding him about all the while!'

277.

THE BUTCHER AND THE BEAR.—An Italian, who possessed a bear, which he had taught to wrestle and dance, was travelling in California. After going through his performances with the bear in front of a farmer's house, he obtained permission to sleep there that night. During the night the people in the farmhouse were disturbed by cries of 'Murder! Help!' and a noise as if someone was struggling for life. The farmer got up, and, followed by the Italian, went to the barn from whence the sounds proceeded and where the bear had been placed for the night. On going into the barn they saw the bear hugging a man and squeezing him almost to death. The man proved to be a dishonest butcher who had gone to the barn to steal a fat calf, and had stumbled over the bear. The Italian, on hearing this, called out 'Hug him, Jack!' and the bear did hug him, till the farmer thought fit to order his release.

278.

HEROISM.—Some time since, a Norwegian ship, in a fearful tempest, was drifting upon a rock near the entrance to Peel Harbour in the Isle of Man. All the inhabitants of the town were down at the beach watching her. The lifeboat was got out, and there were so many volunteers that the harbour-master had no difficulty in selecting a crew. The Norwegian had lost her masts, and the spars were floating around, so that she was dangerous to approach; but the lifeboat reached her. 'How many of you?' cried the coxswain to the Norwegian captain. 'Twenty-two.' The coxswain counted them as they hung on the ship's side, and said: 'I only see twenty-one; not a man shall leave the ship until you bring the odd one on deck.' The odd one, a disabled man, had been left below to his fate. He was brought up, and all were taken aboard the lifeboat and landed safely on the beach. The Norwegian Government presented medals to the lifeboat men in recognition of their bravery.

COMPOSITION TESTS.—STANDARDS V.—VII. AND 1ST & 2ND YEAR P.T.'S.

Write at least 20 lines on *one* of the following:—

13. What you can about shoes and stockings, what they are, how made, materials used, seats of industry, use, etc.; OR

14. In a letter to your teacher describe any holiday you have spent in the country or at the sea-side; OR

15. Say all you can about cleanliness and neatness in dress. Explain what you mean, the importance, necessity, and benefits, etc., then show the evils arising from dirty habits; OR

16. Say all you can about perseverance, what it is, how acquired, evils resulting from the want of it, etc.; OR

17. Contrast autumn with spring, and show the benefits arising from changes in the seasons; OR

18. Say what you can about punctuality, what it is, necessity of it, etc.; then show the ill effects of being 'behind time'; OR

19. Write a letter to your uncle about machinery, and show how its use tends to lower the prices of various articles.

NEW READING TESTS.—STANDARD III.

Suitable for 'Unseen Tests' in Dictation also.

208.—A little boy said he thought his parents intended to move, but he had not heard anything said about it. He was asked for the reason of his opinion, and replied that he had noticed that his father had begun to use the cupboard shelves for firewood, and they generally moved soon after that.

209.—Some people suppose that rosewood takes its name from its colour, but that is a mistake. In colour it is not red or yellow, but almost black. Its name comes from the fact that, when first cut, it sends out a perfume similar to that of a rose; and, although the dried rosewood of commerce retains no trace of this, the name lingers as a relic of the early history of the wood.

210.—As a rule, in German middle-class families there are two good meals a day. These are dinner at one o'clock, and tea at eight. There is no regular breakfast early in the morning. At about seven o'clock the coffee is placed on the stove, and the rolls put on the table, and each member of the family helps himself to coffee and rolls when he comes down.

211.—A gentleman having frequently reproved his servant, an Irish girl, for boiling eggs too hard, requested her in future to boil them only three minutes by the clock. 'Sure, sir,' replied the girl, 'how shall I do that? for your honour knows the clock is always a quarter of an hour too fast.'

212.—In Germany, trees when cut are floated down the streams. Then the trunks are bound together, and formed into great rafts. Sometimes people live on these rafts. The men in charge build tents for their families. Though the rafts are very small when they first start, they get to be very

big by the time the mouth of the river is reached. It is extremely difficult to steer them; but usually they are managed very skilfully.

213.—An Irishman going to be hanged, begged that the rope might be tied under his arms instead of round his neck; for, said Pat, I am so remarkably ticklish in the throat that, if tied there, I will certainly kill myself with laughing.

214.—Once a cat was deprived of all her kittens; most likely they had to share the same fate as many others, and were taken from her to be drowned. At any rate, the poor animal was so unhappy that she actually took under her care some young rats, which she nursed and tended with all the care of a fond mother until they were old enough to look after themselves.

215.—We cannot do without cats, for rats and mice would so increase that we should neither be able to eat or sleep in peace. Pussy treads very lightly, for she walks on her toes instead of the soles of her feet; and well she may, for mice have the most delicate sense of hearing.

216.—In China, that land of curiosities, may be seen oaks, chestnuts, pines, and cedars growing in flowerpots, and fifty years old, but not twelve inches high! They take the young plant, cut off its tap root, and place it in a basin of good soil, kept well watered. Should it grow too rapidly, they dig down and shorten its roots. Year by year the leaves grow smaller, and in the course of time the trees become little dwarfs, and are made pets of like canaries and dogs.

217.—That evening, when they went to wish 'good night,' they held each other by the hand, and they made together a little speech, in which their mother only heard, 'We are very sorry,' and 'downstairs'; but that was quite enough to hear, so she kissed them both, and told them there was something very nice in store for them to-morrow.—(H.M.I.'s Test.)

218. There is a better world than this
Beyond the sea of Time,
Through many a tempest we must pass
To reach that heavenly clime;
But if God be with us, though calm
And storm be mixed together,
What matters it? for heaven we're safe,
E'en through the roughest weather.

NEW DICTATION TESTS.—STANDARD IV.

Suitable for 'Unseen Tests' in Reading also.

No. 154.

The lovely little rice bird is sometimes called the Java sparrow. Its pretty lead-coloured plumage looks almost as though it had a bloom like a plum on it. Its beak is red and strong, so that it can do a great deal of damage among the growing rice; therefore the Indians kill them. When we get one in England, we put it in a cage and take the greatest care of it. It is easy for us to admire and pet it, for it cannot do us any mischief, and it is such a friendly little bird.

No. 155.

The cat's dislike to wet its feet arises from the fact that its fur has nothing oily about it, is consequently very easily wetted, and does not dry at all quickly. Cats are great lovers of warmth, and have an intense dislike to the sense of cold conveyed by clinging wet fur. Some naturalists have asserted that cats dislike to wet their feet because their ancestors were accustomed to the dry soil of Egypt, and the consequent repugnance to damp has adhered to the race, though it has become naturalised in other and wetter lands.

No. 156.

There is an old saying that 'familiarity breeds contempt.' Its truth is very doubtful. There are many things, as there are many people, of which one can say that the more closely you study them the more they grow upon your admiration and regard, and this is certainly true of those beautiful masses of aqueous vapour which we call clouds. To most people the clouds are much the same, but once one begins to carefully study them it is quite wonderful how many points one begins to see in them.

No. 157.

Lions are becoming so scarce in Africa that it is said it will soon be easier to see one in London. Antelopes, lions, buffaloes, rhinoceroses, giraffes, and other large animals which were met with in abundance when the country was first explored are no longer to be found in any part of south-west Africa on account of their ceaseless slaughter. The only large animal of ancient history which remains is the whale.

No. 158.

At Arundel Castle they used to show a bed 'encircled with curtains of delicate crimson, with starry coronets interwoven,' in which, folded between a pair of white and soft sheets, a lost chimney-sweeper was discovered, at noon-day, fast asleep. The story goes that he was the stolen child of wealthy parents to whom he was restored. Instinctively, on finding himself in a chamber in keeping with his own upbringing before being stolen, he had sought rest between the sheets of a duke's bed.

No. 159.

Asses are thought a great deal of in the East, and treated in a very different fashion from what they are here. They are bigger and stronger, and not half so obstinate as our Neddies. In Turkey there is one particular kind, which is beautifully white. Sometimes their masters dye their ears and long tails red or blue, and deck them out in embroidered trappings. These are the gentle-folk donkeys.

No. 160.

On account of the prevalence of intemperance among the men in Holland, women have been employed at railroad switches with great success. Not an accident has occurred since the women were installed in their unique office. If the precedent becomes established that a sober woman is a more valuable servant than a tipsy man, there will be a great revolution in the industrial world.

No. 161.

Friendship is one of the greatest boons that life can have. It redoubleth joys and cutteth grief in halves. But where brotherhood is united with it, it attains a still richer result; for then it has a world of memories and early associations in common—the mutual love of the same honoured parents, the recollections of the same beloved home and of past scenes vividly impressed on the minds of both, in which no other friend, however dear, can possibly share.

No. 162.

The origin of icebergs was long a subject of dispute, but it is now certain that they are derived from the land ice. Off the western shores of Greenland they are very numerous, and there indeed is the chief place of their birth. For they are simply portions of the great stream of ice which, travelling from the interior of the continent, in course of time reaches water deep enough to float its extremity, which is ultimately torn from off the parent mass, and sails away as a huge detached piece.

No. 163.

No true man can see needless pain inflicted on animals without an inward loathing of the cowardly hand that strikes where the victim is helpless and speechless. The very knowledge that they are so entirely in our power for good or for evil, so wholly entrusted to us for service, ought to arouse in us a determination to oppose, by all means in our power, the abuse of that trust. All boys ought to remember that an act of cruelty towards animals is not only unworthy of a gentleman, not only the act of a coward, but a violation of a sacred trust.

No. 164.

Each newspaper has its news' correspondents abroad, and there is great competition as to which shall have the earliest and most interesting information. This service entails a great outlay of money, and naturally, when it yields anything there is a disposition

to make the best show of it. When a war breaks out it is usual for the leading newspapers to send out specially skilled writers to describe the conflict.

No. 165.

I love it ! I love it ! and who shall dare
To chide me for loving that old arm-chair ?
I've treasured it long as a sainted prize,
I've bedewed it with tears, I've embalmed it with sighs ;
'Tis bound by a thousand bands to my heart ;
Not a tie will break, not a link will start !
Would you know the spell ?—a mother sat there !
And a sacred thing is that old arm-chair.

STANDARDS V.—VII., AND 1ST AND 2ND YEAR P.T's.

No. 141.

A GENTLEMAN, who, a few years ago, resided some time at Grand Cairo, has described the punishment of bakers and butchers in that city. That which was inflicted on bakers whose bread was deficient in weight was extremely severe. For the first offence, the overseer of the baker (who is the examiner and only person who tries them) immediately orders the delinquent to be bastinadoed. For the second offence, he is more severely punished in the same manner ; and for the third, without any other process than the above-mentioned officer's order, he is put into his own oven when hot, where he is suffered to perish ; which punishment, the gentleman adds, he saw executed.

No. 142.

OF the causes of disease, anxiety of mind is one of the most frequent and important. When we walk the streets of large commercial towns, we can scarcely fail to remark the hurried gait and care-worn features of the well-dressed passengers. Some young men, indeed we may see, with countenances possessing natural cheerfulness and colour, but these appearances rarely survive the age of manhood. What we would urge is a moral. Civilization has changed our character of mind as well as body. We live in a state of unnatural excitement—unnatural because it is partial, irregular, and excessive. Our muscles waste for want of action ; our nervous system is worn out by excess of action.

No. 143.

IT is a mistake to labour when you are not in a fit condition to do so. To think that the more a person eats the healthier and stronger he will become. To go to bed at midnight and rise at daybreak, and imagine that every hour taken from sleep is an hour gained. To imagine that if a little work or exercise is good, violent or prolonged exercise is better. To conclude that the smallest room in the house is large enough to sleep in. To eat as if you had only a minute to finish the meal in, or to eat without an appetite, or continue after it has been satisfied, merely to satisfy the taste. To believe that children can do as much work as grown people, and that the more hours they study the more they learn.

No. 144.

TO abbreviate and neglect the forms of politeness is really to diminish the sentiments and the needs of the heart. As soon as one ceases to express outwardly even the most essential sentiments, these sentiments become weakened to a certain degree in the soul ; they lose something of their delicacy and of their energy. The cultivation of the forms of politeness must be begun in family life between husbands and wives, parents and children, brothers and sisters. Till courtesy is honoured in the household it will not appear elsewhere.

No. 145.

IT is no uncommon thing for a man who has lived a life of full business activity for many years, to find that as soon as he retires from business, mysterious symptoms of bad health begin to appear. The meaning is that he has moved so long in a set routine, that his body has become unaccustomed to any change of condition, and resents it. On the other hand, the man who knows how to break the set order of his life occasionally with a little harmless irregularity, confers a benefit on himself. He returns to his routine fresher for the change, and takes up his work again with a sense of enjoyment and vigour. We have no doubt that this is true, and paradoxical as the saying looks, nevertheless it is substantially correct that excessive regularity of habit is almost as injurious to health as Bohemian irregularity.

No. 146.

MENTAL idleness is sure to lead to mental ruin. He who will not exert his thoughts, who lets them passively receive whatever influence may chance to fall upon them, will soon lose the chief power which makes them valuable. It is an easy habit to fall into, and one which each person needs to guard against—that of listlessly reading, or listening, or dreaming, instead of actively thinking and working up these influences into ideas and convictions that are worth holding, because they have been justly earned. It is the vacant mind, where no seed is struggling upward into life, which will soonest be covered with weeds.

No. 147.

THERE is often a great deal of selfishness shown by people who imagine themselves very unselfish people indeed. A woman will seriously affirm that it is the height of selfishness, when work is concerned, to think of her own health, or make any arrangement for her own comfort. Although a little care and thought on her part for herself might prevent serious results, involving trouble to others, the idea never seems to occur to her that it is selfish of her not to take them. Not selfishness, but thoughtfulness for other people, should prompt a woman to keep herself in good physical and mental health. Duty to her family demands that she should take not only ordinary precautions, but extra ones too, when required to prevent illness. Matters pertaining to health which she would never overlook in her children, she should not ignore in her own case or feel them of lighter moment.

No. 148.

THE fog is caused by atmospheric conditions which keep the lower stratum of air comparatively stationary and prevent smoke from rising, as it ordinarily does even when there is no wind to move it. Consequently, the air in our streets remains to a great extent unchanged during the prevalence of a thick fog, but it by no means remains in the same state, for the gas generated in the 2,500 miles of sewers is rising through the grids and mixing with the air, which is also being corrupted by the emanations from the millions of human beings and animals that live in the metropolis.

No. 149.

IT is a common idea that generosity consists mainly in giving. The generous man, it is said, is one who is always ready to impart that which he has to those who need it. He is bountiful in hospitality, liberal in his gifts, munificent in his charities. He is perhaps willing to give his time, as well as his money, to impart knowledge to the ignorant, counsel to the erring, sympathy to the sorrowing. Whatever powers he may possess he uses freely for others' benefit, and his affections, which are deep and strong, descend upon thirsty souls to bless and invigorate, as the gentle rain descends upon the parched earth, to refresh and make it fruitful.

No. 150.

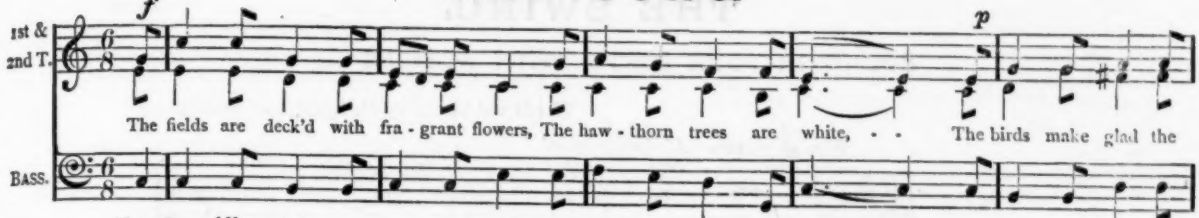
A COMPANY has been formed recently in Colombo for the purpose of establishing a floating hotel in the harbour. It is proposed to build a hulk of large dimensions, flat-bottomed, and capable of supporting a fairly large establishment. The promoters consider that it will prove popular among the planters, offering advantages over other seaside hotels, and that the passengers on the great Australian and Indian liners which call regularly at Colombo will patronise the hotel in considerable numbers; while it is also claimed that the average resident would enjoy the novelty of the thing. (H.M.I's. Test.)

No. 151.

THERE comes to me amid the toil and fret
Of the long, busy day a picture sweet,
Without which life would never be complete,—
Undarkened by the shadow of regret,
A dear old-fashioned face that charms me yet,
Smiling from soul unsullied by deceit,
Recalling happy hours which fled too fleet,
Crowded with memories I would not forget,
Brightening the misty canvas of the past ;—
My truest friend, proved by unselfish test,
Whose character in noblest mould was cast,
Whose memory holds my heart while life shall last.
Death claimed him long ago, as it was best,
For so his tired soul found sweetest rest.

MAY SONG.

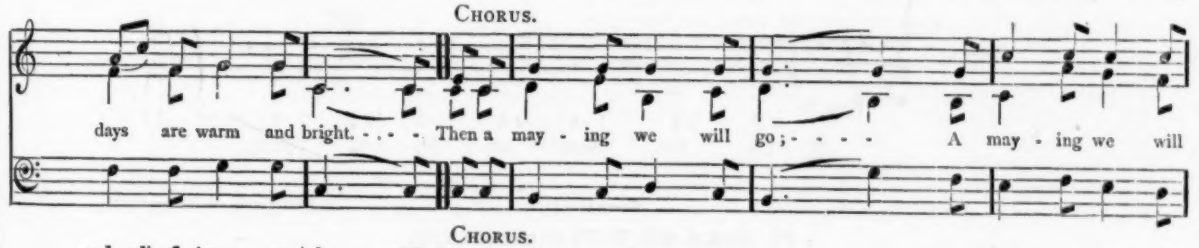
Allegretto.



Key C. *Allegretto.*

1st & 2nd T.
B.
The fields are deck'd with fra - grant flowers, The haw - thorn trees are white, - - - The birds make glad the
sun - ny hours, The birds make glad the sun - ny hours, The days are warm and bright, - - - The
sun - ny hours, The birds make glad the sun - ny hours, The days are warm and bright, - - The

CHORUS.


days are warm and bright. - - - Then a may - ing we will go; - - - - A may - ing we will
days are warm and bright. - - - Then a may - ing we will go; - - - - A may - ing we will

CHORUS.

go; - - - - To deck our bowers with bloom - ing flowers, A may - ing we will go. - - - -
go; - - - - To deck our bowers with bloom - ing flowers, A may - ing we will go. - - - -

The chilly days of early Spring,
With April showers are past,
The cuckoos welcome tidings bring,
The cuckoos welcome tidings bring,
That Summer's come at last;
That Summer's come at last.

Chorus.

We'll ramble o'er the meadows fair,
Beside the murm'ring rill,
And fragrant boughs of hawthorn bear,
And fragrant boughs of hawthorn bear,
From hedgerow, grove, and hill;
From hedgerow, grove, and hill.

Chorus.

THE SWING.

ROUND IN FOUR PARTS, WITH ACTIONS (*ad lib.*).

Words and Music by H. BERKELEY SCORE.

Mm. ♩ = 100. Moderato assai.
Part 1.
Key D.
| m .f :m .r | d :r | m :s | s :— |
(*) Come, O come out for a swing,
Part 2.
Key D.
| s .l :s .f | m :f | s :d' | d :— |
(†) High to rise like bird on wing,
Part 3.
Key D.
| d :s | d :s | d :s | d' :— |
(‡) Swing! Swing! Swing! Swing!
Part 4.
Key D.
| d' :d | s :t | d' :s | m :— |
(§) 'Tis the sweet - est joy in Spring.

ACTIONS.

(*) Beckon with hands or point to door.
(†) Point to ceiling of room.
(‡) Wave hands upwards and then down again.
(§) Clap hands and beat time with feet.

NOTES AND NOTIONS.

BY RICHARD WADDINGTON.

THE result of the election of the Vice-President of the N.U.T. has once more illustrated the confidence of the members of the Union in Mr. Macnamara. To thrice head the list of successful candidates at the annual election of the Executive is a record that most people would be proud of, but to be elected to the more onerous and important position of Vice-President by a majority approaching ten thousand is a tribute that falls only to the few. And no man more really merits the tribute. It is not only a tribute to Mr. Macnamara, but an evidence of the discrimination of the members of the Union. No man has wrought harder, or is doing more, for teachers than next year's Vice-President. When I hear Mr. Macnamara, earnest, eloquent, and alert, pleading the cause of education with such zeal, I always find myself muttering:—

'We fail!
But screw your courage to the sticking place,
And we'll not fail.'

* * * * *

TRULY Mr. Macnamara 'bears his blushing honours thick upon him.' Elected a member of the London School Board by the highest vote recorded throughout London, at the first time of asking, and elected Vice-President of the Union all but unanimously are records that few men make so early in life. But it is an open secret that if the President for 1896 is willing more than one London constituency will nominate him for a seat at Westminster. I hope to see a House of Commons which contains Messrs. Macnamara, Gray, and Yoxall. And then there will be a varied and suitable occupation for whoever is Vice-President of the Council.

Mr. Ellery seems likely to have a golden opportunity at the Manchester Conference. The political barometer seems as fickle as the frost is stubborn. Even if the long-sought Superannuation Bill is not to hand the Report of the Departmental Committee on Superannuation will form the basis of an admirable address, especially in the hands of Mr. Ellery. But failing these, the Code for 1895 is nearly certain to be issued by the opening of the Conference. To voice the opinions of the 27,000 members of the Union on these important topics might well make the boldest pause; but I feel sure the President of the Manchester Conference is too fully alive to the dangers of undue enthusiasm to fail to turn the occasion to good account.

* * * * *

The Manchester Conference bids fair to be the scene of much stirring of the waters. The Manchester and Salford teachers are making preparations that will ensure the comfort of representatives. The Conference is to be housed in the Central Hall in Oldham Street. The hall in which the Conference is to be held is one of the most compact and well-arranged that a Conference has ever been held in. The reception of purses is to take place in the Free Trade Hall, within whose walls historic associations have been many and important. But the tribute of the four hundred associations to the fatherless and friendless will be a fitting addition to the noble record of tireless industry of the teachers of Cottonopolis.

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The opening of Parliament has not brought to light a great desire to legislate on matters educational. Mr. Acland's Tenure Bill remains still in the future. There is to be a Goverment Factory Bill, and Sir Henry James is also to introduce a Factory Bill. The Miners' Eight Hour Bill has so far been unsuccessful in the ballot. In these measures effort will be made to do for all save the children. The anxiety to legislate increases with the power to fill the ballot box, and, here, the children are impotent. Sir Henry James will struggle to improve the lot of the adult, but, as in 1891, I suppose he will be found indifferent to the cry of the 'half-timer.' But the case of the eleven year old toiler will not go by default. The N.U.T. is strong enough, as it was in 1891, to secure another year at least of respite for the little piecer. The editor of the *Schoolmaster* has given the cry of the child-worker a prominence and publicity that must do much to make legislation easy. It is a pity that the protection of the children generally meets with the opposition of the artisans of Lancashire and Yorkshire, but the shame is theirs.

* * * * *

'The Stars and Daggers' looked like becoming a question of more than passing interest. Years ago, the voting paper for the Executive was so arranged that all the retiring members were printed on one side, and all the aspirants to Executive honours on the other side. When that was abolished the retiring members were distinguished by an asterisk. At the last meeting but one of the Executive it was decided to retain the asterisk and to add a 'dagger' to the name of each District Union representative. But at the last meeting of the Executive all distinguishing marks on the voting paper were abolished. Thus ended the grave crisis. That the distinction was unfair to the other candidates needs no demonstration, and that the Executive would have acted in an undignified manner had it retained the distinction is equally true. If the members of the Union are so badly informed as to require such guidance, then it is a pity to have an election at all. The present Executive might as well elect their successors. But I do not believe this indifference exists. Cases can be quoted where individuals have shown a woeful lack of information, but the great bulk of the voters know the men and why they support them.

* * * * *

How Authorities Differ.—The reading class was standing in a row upon the floor of an Indiana schoolhouse, and a bright little fellow was drawling a paragraph about a Roman massacre. The president of the School Board was present on his regular tour of inspection, and he pompously requested that the boy 'read that verse again.' The 'verse' was read again. 'Ah! h'm!' said the great man in a loud voice, 'why do you pronounce that word massaker'? The boy was silent. 'It should be pronounced massakre,' continued the great man, with a patronising smile. The boy remained quiet, but the teacher finally spoke. 'Pardon me, sir,' she said, 'but the fault is mine if the word was mispronounced. I have taught the class to pronounce it massaker.' 'But why?' insisted the great, man as a look of surprise was followed by a look of pain upon his benign features. 'I believe that Webster favours that pronunciation,' said the teacher meekly. 'Impossible,' said the great man. The dictionary was brought and the president of the School Board turned over its leaves until he found the word. There was breathless silence as he looked up, for there the word was 'massaker.' 'I am astonished, madam,' he said at last, 'that Daniel Webster should have made such a mistake as that.'—*Detroit Free Press.*

* * * * *

The managers of a London Board School report:—'An organ plays for half an hour in the Girls' playground on Friday afternoons during the fine weather, so that the children may dance.' And why not? It is a poor heart that never rejoices, and after a week's struggle with the laws of syntax and 'the diagonal darn cut,' a festive half-hour tripping the light fantastic toe to the strains of 'Daisy, Daisy,' must do much to invigorate both teachers and taught. Will this be considered a suitable occupation by 'My Lords'?

* * * * *

'Salary Saturday,' which by the way was not adopted at the Nottingham Conference, as I inadvertently stated last month, but at the first meeting of the Federal Committee held at Sheffield and presided over by Mr. C. H. Moore, who has laboured zealously to improve the lot of the class teachers, was an undoubted success. True, several towns that might have been expected to 'line up' have not moved this year, but sufficient has been done to show the advantage of simultaneous and combined effort to inform the public mind. In such efforts one always feels regret that the class teachers in Voluntary Schools are not able to lay their case before the public with the authenticity of the Board class teacher. Except from the Blue Book, information as to the pay of the class teachers in Voluntary Schools is difficult to obtain. And there can be no doubt that bad as is the Board teacher's pay, in many instances the Voluntary teachers generally fall below it. Of course, the improvement of the Board teacher of necessity improves the Voluntary teacher.

* * * * *

There appears to be considerable fear of the introduction of Composition into the lower standards.

My opinion is that this very largely arises from a misconception of the full meaning of Mr. Acland's declaration last December. The deputation asked that Dictation should be abolished as a test of spelling, and that above the Fourth Standard the only test should be Composition. But let me quote the letter from the Executive sent to the Education Department, which says :—

'Spelling and Composition.—The Executive suggest that there be no tests in spelling applied until the Fifth Standard, and that the spelling tests in the Fifth and higher Standards be made from the exercise in Composition.'

The object was to substitute a single for the present double-barrelled test in the Fifth and higher Standards. In many districts the Inspector has wisely neglected the Dictation test, but in others the Dictation test has been applied with anything but good results to teachers and taught.

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My opinion is that Mr. Acland desired to announce his willingness to accede to this when he said the only test of spelling should be Composition. Therefore, I take it, there is no necessity to anticipate Composition in the first four Standards. What I do anticipate is the extension of Word-building to the Fourth Standard, and the abolition of the Dictation test in all Standards. Very possibly the Department will issue more definite instructions as to the Word-building Course, and will lay down Transcription as the written exercise. It is not difficult to see that to enforce Composition in the lower Standards of the rural schools would be aggravating rather than relieving the difficulty.

* * * * *

The regulations just issued by the Science and Art Department for Organised Science Schools fully illustrate the absurdity of having two authorities dealing with education. Years ago the Merit Grant was consigned to a well-earned oblivion at Whitehall, but to-day the authorities at South Kensington are attempting to apply the Merit Grant in its most pernicious form to Organised Science Schools. In the Primary Schools during the days of the Merit Grant it was true—

'At every word a reputation dies,'

and one can imagine in the Organised Science School, where the difference between one class and another may mean hundreds of pounds, that all possibility of real education will be out of the question. There is one point that so far seems to have escaped notice. The new syllabus includes Physics in the obligatory subjects, while under the present syllabus it is optional. Teachers qualified to teach the whole of the present course may not be qualified to teach the whole of the new course, and once more must the Science Teacher seek a new qualification. Surely the Science teachers have a right to demand that the Department shall not be continually driving them to seek certificates of competence to teach.

* * * * *

And how much will depend upon the newly-created Inspectors of Science and Art? Have these gentlemen had special training in the Art of Pedagogy? I have sought in vain for their record of work done within the four walls of a school as teachers. And yet, on these Inspectors is to devolve the task of deciding the fate of the teachers. The Organised Science Schools are to have intermittent inspection *and* the fixed annual examination. The time has more than come for the merging of the Science and Art Department and the Education Department into one central authority for dealing with education.

* * * * *

Mr. Organ is a candidate for the London County Council. The able Law Clerk will make a right good councillor, and I wish him every success, as I am sure do all the members of the Union. Councillors, Aldermen, and Justices of the Peace, are getting so plentiful in the profession that one is reminded of the story of the Irishman who had just returned from Dublin, and who said :—'Ah, sure, an every man I met was either an M.P. or the wife of an M.P.' It is a tribute to the influence of the teachers that so many are elected to represent the people in the Local Parliaments, and this has been especially so in Rural England during the creation of the Parish Councils.

* * * * *

It will be remembered that during the Coal Strike teachers were good enough to send me funds for feeding the children in and around Lancashire. That these funds did much to assist teachers to ward off the hunger that was too prevalent I had ample testimony, but I have just had a more tangible and pleasing recognition. Among the schools assisted by the Fund was the Bolton Road Mixed School, Atherton, and at the last meeting of the Bolton Association Mr. Belshaw, the master, handed in £5 for the N. U. T. Charities. The sum was the proceeds of a concert arranged by Mr. Belshaw to give the people an opportunity of returning their thanks. Well done, Atherton!

* * * * *

Before me lies an admirable 'Appeal to Members of School Boards, Managers of Voluntary Schools, and others interested in Primary Education,' issued by the National Federation of Assistant Teachers. The appeal is couched in convincingly moderate and practical language, and is supported by the Scales of Salaries paid by School Boards to Assistant Teachers. There is nothing like well arranged facts for appealing to the crowd, and the facts are here in dull, cold type, arranged in a handy form. Every Unionist ought to secure a copy.

* * * * *

A copy of the *Burton Evening Gazette* has reached me wherein I read the last Liberal Club Debate was on 'Child Labour.' Mr. Tickner's paper was full of information, and the resolution passed unanimously runs :—'That this meeting strongly deprecates the employment of children under fourteen years of age, sincerely trusts that half-time labour will be abolished as an act of justice to the children, and would urge on the Government to introduce into Parliament at an early date a Bill which would at least raise the age to that pledged by England's representative, Sir John Gorst, at the Berlin International Conference in 1890.'

MODEL ANSWERS TO QUESTIONS SET AT THE QUEEN'S SCHOLARSHIP EXAMINATION,

DECEMBER 1894.

GEOGRAPHY—*continued from p.* 436.

The great railways connecting England and Wales are :—

London and North Western. London stations—Euston and Willesden. *Stations in or near Wales*—Shrewsbury, Chester, Llandudno, Bangor, and Holyhead.

Great Western, with its London terminus at Paddington. *Stations in or near Wales*—Bristol, Newport, Cardiff, Swansea, Shrewsbury.

Edinburgh, 401 miles from London. Routes by Great Northern, North Eastern, and North British, forming one continuous route by York, Newcastle-on-Tyne, and Berwick. Also by the London and North Western and Caledonian through Carlisle. Also by Midland and Caledonian.

Dover, 78 miles from London. Routes by the London, Chatham and Dover through Chatham, and the South Eastern by Ashford and Folkestone.

Southampton, 79 miles from London. By the London and South Western from Waterloo, through Basingstoke.

Exeter, 172 miles from London. By the Great Western, through Reading and Swindon. Also by South Western from Waterloo.

Oxford, 63 miles from London. By Great Western, through Reading. Also by London and North Western.

Derby, 129 miles from London. By the Midland from St. Pancras, through Wellingborough, Kettering, and Leicester.

Peterborough, 76 miles from London. By Great Eastern from Liverpool Street. Also by Great Northern, through Hitchin and Huntingdon.

4. Name the countries which touch the Mediterranean Sea, and those which touch the Baltic Sea. Say briefly what is the government of each country, and what you know of the religion of the inhabitants ; or explain, in words or by a sketch map, the position of Corea in relation to China, Japan, the Russian Empire, the Yellow Sea, and the Sea of Japan.

Touching the Mediterranean Sea :—

1. *Spain.* The Government is a Limited Monarchy, and the religion Roman Catholic.

2. *France*, governed by a Republic. The majority of the people are Roman Catholics, but there is a considerable number of Protestants.

3. *Italy.* The Government is a Limited Monarchy, and the religion almost entirely Roman Catholic.

4. *Austria.* The Government is a Limited Monarchy, and the religion mainly Roman Catholic. But there are about 4,000,000 Protestants, nearly 2,000,000 Jews, and a considerable number of members of the Greek Church.

5. *Montenegro.* Governed by a Prince, whose power is limited by a Council of State. The religion of the majority is that of the Orthodox Greek Church.

6. *Greece.* The Government is a Limited Monarchy, and the religion that of the Orthodox Greek Church.

Touching the Baltic Sea :—

1. *Denmark.* The Government is a Limited Monarchy. The majority of the people are Protestant.

2. *Mecklenburg-Schwerin.* A Grand Duchy, forming one of the Federated States composing the German Empire. The power of the Grand Duke is limited by a Representative Assembly. Protestantism is the dominant religion.

3. *Prussia*, a Limited Monarchy. The King of Prussia is also German Emperor. Protestants form the majority in Prussia, but there are many Roman Catholics.

4. *Russia.* The Government of Russia is Despotic, under a Czar. The State religion is that of the Orthodox Greek Church, but there are also many Jews.

5. *Sweden*, a Limited Monarchy. Protestantism is the religion of the majority of the people.

Corea is situated to the north-east of China, to the south-west of Japan, to the south-east of the Russian Empire, on the north-eastern side of the Yellow Sea, and on the south-western side of the Sea of Japan.

5. Write out a summary of the information which you would give, and point out the ideas which you especially wish to convey to your pupils, about the rainfall and rivers of Northern India, *or* about a journey from Liverpool to New Westminster.

The rainfall of Northern India is excessive in the Eastern Himalayas. Parts of Assam are among the wettest regions on the earth's surface. As much as 600 inches of rain per annum have been registered in some parts of Assam, or more than 25 times as much as the mean annual rainfall of London. Going towards the north-west, the rainfall gradually diminishes, till in the southern part of the Punjab, and in the Great Desert, it is only 6 to 7 inches per annum. The rain depends on the south-west monsoon, which, blowing across the Indian Ocean, is laden with moisture. This wind blows from June to September.

The chief rivers of Northern India are :—

(*a*) *Flowing into the Bay of Bengal.*

(1) The *Brahmaputra*, which rises on the north of the Himalaya Mountains, and after flowing eastward, bends round to the south-west, and then south, and flows into the Bay of Bengal near the Ganges.

(2) The *Ganges*, rising in the Himalayas. Chief tributaries, the Jumna, Chambol, and Gogra. Many important towns are on the Ganges or its tributaries. The chief are Cawnpore, Lucknow, Benares, Patna, Allahabad, and Calcutta.

(*b*) *Flowing into the Arabian Sea.*

The *Indus*, with its tributaries, Chenab, Jehlam, Ravi, and Sutlej. The main stream, with these tributaries, drains the country of the Five Rivers, or Panjab. The chief towns in the basin of the Indus are Lahore, on the Ravi; Multan, on the Chenab; and Hyderabad, on the Indus.

Taking steamer from Liverpool to Halifax, in Nova Scotia, we should have a journey by sea across the Atlantic Ocean, and lasting more than a week. After calling at Queenstown, we should soon lose sight of the Irish coast, and should not sight land again till we got to America. In going across the Atlantic we might, if in the spring time, see icebergs, and possibly might be detained by fogs when nearing the American coast. Arrived at Halifax, we should take the Canadian Pacific Railway, passing through Nova Scotia, New Brunswick, the southern part of Lower Canada, inhabited by French-speaking people, and Upper Canada, where the language spoken is English, the people being mainly of Scotch and English descent. After leaving Ottawa, we should pass through less settled districts and through great extents of forests. Passing near the northern end of Lake Superior, our course would lie almost due west. Many of the passengers in the train would probably be bound for Manitoba, a country containing much rich farming land, and which has attracted many emigrants within the last twenty years. After parting with these, our route would lie through hundreds of miles of a lonely district of lakes and forests. Nowhere along the route should we see hills of any magnitude until we approached the Rocky Mountains. Crossing these by train we should probably find rather cold work, but the grandeur of the scenery would be some little compensation for the discomforts we had to endure. We should now pursue our journey across British Columbia, gradually leaving the spurs of the Rockies, and getting into more level country as we approached the sea. Crossing the River Fraser, which here makes a curve southward, we should in a few hours reach New Westminster, at the mouth of the river.

6. State what you know about the position, the people, the history, of San Francisco, New Orleans, Buenos Ayres, Cape Town, Hong Kong, Port Said, Constantinople.

San Francisco, chief port of California, on the Pacific coast of the United States. Its population is 250,000, the majority of whom are English-speaking by birth, but there is also a large number of Chinese. San Francisco was founded by Spaniards, who formerly ruled California.

New Orleans, near the mouth of the Mississippi, is the capital and port of Louisiana. A very large proportion of its inhabitants are of French descent, and speak French. There are also many creoles. The State of Louisiana was colonized by the French, who were dispossessed of it as a result of the Seven Years' War. In 1814 New Orleans was attacked by the English, but successfully defended by General Andrew Jackson.

Buenos Ayres, the capital of the Argentine Republic, is situated at the mouth of the La Plata River. It has a population of 540,000. The people are mostly of Spanish descent, as the Argentine Republic was one of the colonial possessions of Spain until separated from the mother country by a successful revolution in the present century.

Cape Town, on Table Bay, is the chief town and port of Cape Colony. It was founded by the Dutch, who colonized South Africa, but who were finally dispossessed of it by the English in 1806. A large proportion of the population are Dutch by origin and language.

Hong Kong, an island with a town of the same name at the mouth of the Canton River on the south-east of China. Came into the possession of England in 1841, as a result of the first China war. The majority of the inhabitants are Chinese.

Port Said, on the Mediterranean, at the north end of the Suez Canal. It owes its origin and its present importance to its position on this great international highway. It was so-called after Said Pacha, the Viceroy of Egypt who granted the concession for the construction of the Suez Canal.

Constantinople, on the Bosphorus, the capital of Turkey, derives its name from the Emperor Constantine, who raised it to importance by removing the seat of government from Rome to Constantinople. It was formerly called Byzantium. After the fall of the Western Empire, it remained the capital of the Eastern Greek Empire until its capture by the Turks in the middle of the fifteenth century. The population is 873,000. Turks form the majority of the population, but there are also many Greeks and Armenians, and, in greater or less number, representatives of every European nation.

7. Name countries south of the Equator which are inhabited by people of European descent. Say from what European countries these people are derived, and say what you know about their relations with Europeans and wi h people of non-European descent.

The following are the countries asked for :—

(*a*) In South America.

(1) *Peru*, where the people are of Spanish descent Peru has been independent of Spain since 1821. It does great trade with England.

(2). *Bolivia*, also a former Spanish possession, and inhabited by a Spanish-speaking race. There are many Indians and people of mixed birth.

(3) *Chili*, a former Spanish possession, inhabited by Spanish-speaking people. There has been, however, a great mixture of races in Chili. Chili, which is an enterprising country, contains many foreigners of various nationalities, and numerous tribes of Indians, who possess like political privileges with the whites.

(4) *Argentine Republic*, a former possessjon of Spain. The dominant language is Spanish, but there are also many inhabitants of English, Scotch, German, and Italian nationality. The extensive prairies are inhabited by the Gauchos, who are of a mixed race, half Indian and half Spanish. The country does a large trade with England, France, and Germany.

(5) *Paraguay*, also a Spanish-speaking country.

(6) *Uruguay*, a former dependency of Brazil, inhabited by people of Portuguese descent.

(7) *Brazil* was colonized by the Portuguese. Until 1889, Brazil was an Empire, independent of the mother country, but ruled by an Emperor of the reigning family of Portugal. Since 1889, the government has been republican. The majority of the people speak Portuguese, but there are many Negroes, Indians, and Mulattoes.

(*b*) In Africa.

(1) *Cape Colony*, an English possession. Many of the inhabitants, however, are of Dutch origin, and speak Dutch. There are also many natives, or Hottentots.

(2) *Natal*, containing a larger proportion of English-speaking people than Cape Colony, is also an English possession. The colony contains a mixed population, consisting, in addition to English-speaking people, of Dutch, Zulus, Hottentots, Chinamen, and Hindoos.

(3) *Orange Free State*, an independent Republic, mainly inhabited by people of Dutch descent.

(4) *The Transvaal Republic*, which is independent of England in everything except its foreign relationships. The majority of the inhabitants are Dutch in descent and language, but the great immigration of miners from England, consequent on the discovery of gold, is throwing the balance of power more and more into the hands of the English.

(5) The Island of *Mauritius*, in the Indian Ocean, which now belongs to England, but contains a large proportion of people who are French in descent and language.

(*c*) In Australasia.

(1) *Australia*, *New Zealand*, and *Tasmania*, mainly inhabited by colonists from the British Isles or their descendants. In Australia and New Zealand there is a diminishing number of native inhabitants. In Queensland are many South Sea Islanders, and in Victoria a large number of Chinese.

(*d*) In Polynesia.

New Caledonia, a French penal settlement. A large proportion of the population are French in descent and language.

DOMESTIC ECONOMY.—WOMEN.

SECTION I.

1. How would you define *food?* Upon what properties do the nutritious qualities of the following articles of food depend:—Bread, potatoes, fish, bacon, jelly, butter?

(*a*) FOOD consists of those substances which are taken into the body to build up and repair its tissues and to produce heat.

(*b*) *Bread*, for its nutritious quality, depends upon the presence of gluten in the flour, gluten being one of the nitrogenous or flesh-forming substances.

Potatoes depend on the starch which is present in large quantities, and which, being an amyloid, produces heat. Probably, too, some of the starch is turned into sugar during the process of digestion, and assists in the formation of fats.

Fish contains a considerable proportional quantity of phosphates, which are invaluable as brain food.

Bacon and *Butter* both depend on the presence of fat for their nutritive value.

Jelly contains gelatine, another form of nitrogenous or flesh-forming food.

2. Describe the various ways in which eggs may be used in cooking.

Eggs may be used in cooking thus:—

1. They may be boiled, fried, baked, or poached separately, and served thus, or with toast.
2. They are well beaten and used to mix cakes, puddings, and batters. Sometimes only one or two eggs are added, and the cakes, etc., are mixed chiefly with milk or water.
3. Eggs are used with rice, tapioca, sago, etc. and milk, and baked to form 'milk puddings.'
4. When boiled hard, eggs are used to make sandwiches. Or chopped finely, they form one of the ingredients for making salad and stuffing for poultry. They are also cut in slices and used to garnish several cold meat dishes.
5. Omelettes are made of eggs which are fried—sometimes alone, sometimes with herb seasoning.
6. The white of eggs alone is used for icing, for brushing over cakes and pies, to give them a smooth shining appearance, and, when whipped, to ornament many fancy dishes.

3. What precaution will you take to secure pure milk? How may it be kept from turning sour? Show that milk is rightly termed a model food for young children.

As far as possible milk, to ensure its purity, should be obtained from some well-known dairyman or milkman. It is often safer to obtain it from a milkman who keeps few cows and has a small business, than from one who has many customers. The latter is frequently compelled to buy milk from others to supply the demand, and that milk may not be pure. If doubts arise as to the purity of the milk, it may be sent for free analysis to the Public Analyst.

Milk can be kept from turning sour by adding to it a very small quantity of sugar, salt, or carbonate of soda. It may also be 'scalded,' *i.e.*, milk is placed in a jug which is put in a saucepan containing cold water. The jug is allowed to remain in the water until the latter just boils. It is of primary importance that all utensils to hold milk are quite clean and cold. Earthenware vessels are the best.

Milk is termed 'a model food for young children' because it contains in correct proportion all the materials necessary to build up the various parts of the body. The nitrogenous or flesh-forming substances are represented by casein and albumin, which in cow's milk form 4·78 per cent. of the whole. 3·5 per cent. of fats, and 4 per cent. of sugar build up the fatty tissues and produce heat, whilst a small percentage of salts for muscle, bone, and brain, and 87 per cent. of water, complete the necessary substances for health and growth.

SECTION II.

1. Compare the advantages of linen, cotton, and woollen clothing with regard to durability, health, and economy.

The respective advantages of linen, cotton, and woollen clothing are as follows:—

(*a*) *Durability.* Linen is by far the most durable of the three, then comes cotton, and lastly wool.

(*b*) *Health.* Woollen clothing is preferable as far as health is concerned, as it readily absorbs moisture without feeling wet. This lessens the tendency to chills. The slight friction produced by woollen garments tends to promote a healthy action of the skin. When woollen garments are worn, much less clothing is required, and the decreased weight is of

great value in preventing useless waste of energy. Linen is the most dangerous to health. It is so closely woven that it readily absorbs the moisture from the body, instead of allowing it to pass through the material, and so tends to chill the body. Cotton is much less dangerous, as it more readily allows for the evaporation of moisture, but it cannot compare with wool in this respect.

(*c*) *Economy.* Although the initial cost of linen is greater than that of cotton or wool, it lasts so much longer that it really is the cheapest. Woollen clothing is the least economical, as good soft woollen garments are expensive, and no matter how good the wool may be, it always shrinks more or less when washed, so that the garments do not last so long. Cotton forms a medium between linen and wool from an economical point of view.

2. Give a short account of the manufacture and properties of soap, starch, soda, and blue. What kinds of clothing do not require the aid of these substances in the processes of washing and 'getting-up?'

Soap consists of an alkali united with some fatty or oily acid. It is prepared by boiling the fatty matter with an aqueous solution of caustic soda. When these combine, salt is added, which increases the density of the lees, so that the soap rises to the surface of the liquid and can be collected. Its usefulness depends on its solubility in water.

Soda is an oxide of the metal sodium. In some places native carbonate of soda is found, resulting from the residue of the evaporation of mineral waters. Soda was formerly almost entirely procured from marine plants, but is now manufactured on an immense scale from common salt, which is a compound of sodium and chlorine. Soda is used to soften hard water for the purposes of washing. It should not be used with coloured articles as it bleaches them.

Starch is contained in the seeds of corn and pulse, in many kinds of tubers, and sometimes in wood, bark, and leaves. It is prepared from wheat flour by forming it into a paste with water. This is then kneaded under running water so long as the water which runs off is of a milky appearance. When the water loses its milky appearance, all the starch has been carried off. The milky water is now permitted to stand for a few days to allow fermentation to take place. This gets rid of the sugar and other principles. What remains behind is starch, which now undergoes several processes of purification to prepare it for the market. Starch has the property of stiffening fabrics soaked in a solution of it. When a hot iron is passed over fabrics stiffened in starch they become stiffer still, and take a fine gloss.

Blue is a pigment derived from various sources. It is used to diminish the yellow tint of writing paper and linen, to colour starch, and, in washing, to restore the colour to white articles, whose colour has faded.

Soap is not used to wash very delicate laces and trimmings, oatmeal being substituted for it.

Starch, soda, and blue are dispensed with in 'getting-up' all woollen garments, and many fancy materials, such as crépon.

Blue is unnecessary with coloured articles of any description.

3. What are alpaca, velvet, holland, print, serge, muslin?

Alpaca is a material manufactured from the fleece of the llama, alpaca, and vicuna. It is generally mixed with a little cotton.

Velvet is of two kinds:—1. That manufactured entirely of silk, which is easily known by its soft, deep, thick pile. 2. The kind known as 'velveteen,' which has cotton mixed with the silk.

Holland is made from the coarser fibres of the flax plant. It is a smooth, strong material, generally of a more or less brown tint.

Print is a cotton material closely resembling calico, but differing from it in being printed or stamped with various colours and patterns.

Serge is a woollen material, sometimes mixed with a little cotton. It can be obtained in various colours.

Muslin is a thin, light, loosely-woven fabric made of cotton.

SECTION III.

1. What can a teacher do by personal inspection of the children to promote their health? Give the ordinary temperature of a schoolroom, and say how it can be maintained.

By personal inspection, a teacher may promote the health of the children by watching for want of cleanliness, and seeing that such a need is remedied by immediate resort to the lavatories. Chats with the children on personal cleanliness and hygiene will rouse their interest. A watchful teacher will easily detect signs of lassitude and brain weariness, and will introduce gentle physical exercises, whilst windows are wide open if the weather permits. Boots should be inspected, and if the damp penetrates, efforts made to renew them. Many of the children from good homes will readily bring half-worn shoes for the poorer children.

The ordinary temperature of a schoolroom should be from 55° to 60° F., but in summer this temperature will probably be higher. Such a degree of heat may be maintained by artificial means. Fires, and hot air or hot water are the most usual methods employed for this purpose. Hot air or hot water is better than fires, because the heat is more evenly distributed, and if the coils of pipes are laid before a ventilator, the air is warmed before entering the room. This prevents the ingress of cold air for ventilating purposes, which would suddenly lower the temperature.

2. Why is exercise necessary to health? What modes of physical exertion are best (*a*) for infants, (*b*) for girls from 7 to 13 years of age?

Exercise is necessary to health because it invigorates and develops the organs of the body, and enables them to do their work more thoroughly. The body, by the increased action of the skin and internal organs, throws off unnecessary matter which would often lead to disease. The organs of respiration and digestion are stimulated to perform their proper functions, so that the health may not suffer from indigestion or bronchial affections.

Best modes of Physical Exercises:—

(*a*) *For Infants.*—Children under 7 years of age require *easy* ordinary exercises, such as running, marching, skipping, introductory dumb-bell exercises, and playing games. The latter, under proper supervision, can be made a most interesting means of physical development. Great care must be taken to prevent the little ones from becoming over-tired.

(*b*) *For Girls from 7 to 13 years.*—For girls of this age more advanced dumb-bell exercises, bar-bell, club and ball drill are useful. Chest expanding exercises are most necessary. Foot and leg movements to give free play to the muscles of the hip and knee tend to promote a more graceful style of walking than generally prevails. Dancing, skating, and swimming, if indulged in with due care, are amongst the best exercises for girls of this age. Walking in the fresh air is, for children of all ages, a most useful physical exercise.

3. What are disinfectants? Name some which are inexpensive and effective, and say how they should be used.

Disinfectants are substances which counteract the poisons of fevers, probably by destroying the germs to which these diseases are due. Commonly, but erroneously, those substances which remove foul smells are classed under this head, but they are really deoderants only.

Some simple and effective disinfectants are:—

1. *Heat.*—This is one of the most effective disinfectants we possess. It is useful for disinfecting all clothing and other articles which have been used by the patient. Such articles can be baked, steamed, boiled, and, if necessary, burnt. The last is the best plan to adopt in specially virulent cases. Of the three first-named methods, baking is the best.

2. *Cold.*—Exposing infected articles to a great degree of cold prevents putrefactive changes, and arrests the vitality of the germs, but is not so effectual in destroying them.

3. *Carbolic Acid* is perhaps, after heat, the most widely known and powerful disinfectant we possess. It is diluted before use, as in a pure state its action is caustic. Carbolic acid is sprinkled about the room, the floors are washed with it, and a sheet steeped in it, and hung outside the sick-room door, completely isolates the patient. It is also valuable for soaking linen before it is taken from the room.

4. *Sulphur* is useful for disinfecting a sick room after the patient has left it. The chimneys and windows are closed, and an iron vessel containing sulphur is set on fire and allowed to burn in the closed room. This effectually destroys any germs which may be in the room.

5. *Sanitas* is useful to sprinkle on floors, carpets, or clothing, as it leaves no stain, and is a good disinfectant.

SECTION IV.

1. Two assistant teachers live together in town lodgings, each having a salary of £50. How should each lay out her income? Give details of expenditure on clothing.

How to apportion £50 a year.

	£	s.	d.
Board and lodging	25	0	0
Clothing	8	12	6
Washing	1	6	0
Holidays	5	0	0
Railway fare, etc.	1	10	0
Books and classes	2	10	0
Pleasure	0	10	0
Charities	0	10	0
Insurance	2	10	0
Savings	2	11	6
	£50	0	0

Details of Expenditure on Clothing.

	£	s.	d.
1 jacket or macintosh (each year)	1	10	0
1 walking dress	1	10	0
1 indoor dress	1	5	0
1 hat	0	10	0
1 sailor hat	0	2	6
1 pair boots	0	10	6
1 pair shoes	0	6	6
1 pair slippers	0	2	6
3 pairs stockings	0	6	0
6 handkerchiefs	0	2	6
2 pairs woollen combinations	0	15	0
1 pair corsets	0	4	6
2 woollen bodices (for 2 years)	0	7	0
3 pairs gloves	0	6	0
1 silk or woollen necktie	0	2	6
1 flannel petticoat (each year)	0	3	6
1 flannelette nightdress (each year)	0	4	0
1 top petticoat	0	4	6
	£8	12	6

Several of the above articles would last more than one year, so that the expenditure on clothing for the second year would be lessened.

2. What facilities for investing children's savings do the Post Office authorities offer to schools? And what facilities for making sound investments are open to persons of small income?

The Post Office Authorities will accept money which has been paid into school penny banks. Each child is enabled to pay any sum from one penny upwards into the school bank, and the total amount so deposited is received by the Post Office Savings Bank. If desired, a clerk will be sent by the Comptroller to take complete charge of the school bank, so that the school authorities are relieved of all responsibility. In this case, the same rate of interest is paid to each child as if he were an actual depositor in the Post Office Bank. Another facility offered by the Post Office authorities is the form containing 12 blank spaces, into each of which a penny stamp may be placed; when this form is filled, it may be presented to the school bank and will be received at the Post Office instead of money.

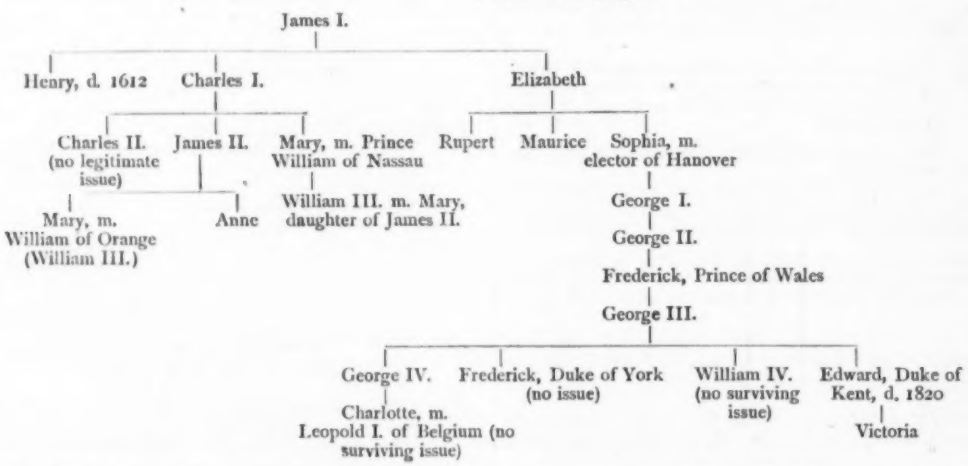
Facilities for sound investments.—The Post Office offers special facilities for investments by persons of small income. By means of its Savings Bank any sum from one shilling up to £50 can be deposited during the year, until a total of £200 is reached. The money deposited may, when desired, be used for investing in Government Stock; the depositor is put to no trouble except that of filling up a form of application for the purpose. Such a small amount as one shilling may be expended in the purchase of Government Stock, and any number of investments may be made during the year.

During the past few years, many good industrial and other companies have been formed with shares of a low nominal value. These shares are easily purchased by persons with small incomes.

HISTORY.—MEN AND WOMEN.

Thursday, December 20th, 11 to 1.

1. Show, by genealogical tables, the claims of William III., George I., and Victoria to the throne. With what Pretenders had the two first to contest the Crown? State, briefly, where and how these Pretenders were defeated. How was the election of William and Mary taken advantage of to settle important questions regarding the succession to the throne, religious disputes, and the independence of the judges?



William III. had to contest the crown with the dethroned James II., who was defeated at the battle of Boyne. A later attempt to restore James was defeated by the destruction of the French fleet off Cape la Hogue.

George I. had to contend with the Old Pretender, the son of James II., whose forces were defeated at Sheriffmuir in Scotland. A rising in England at the same time was put an end to by the surrender of its leaders to the King's troops at Preston.

The election of William and Mary to the throne was taken advantage of to settle the succession to the crown on William and Mary and their children, or, failing their issue, on Anne and her children, being Protestants. Religious disputes were settled by the Toleration Act, which enabled those who did not conform to the Established Church to enjoy the free exercise of their own religion. The judges were made independent of the Crown by the provision that they should hold office during good behaviour, and should only be removable by a joint address of both Houses of Parliament to the Sovereign.

2. State what you know about the Habeas Corpus Act (1679), showing what is meant by its 'suspension,' and the Septennial Act (1716); the Acts of Union with Scotland and Ireland (1707) and (1801); the Peace of Utrecht (1713), and the Peace of Versailles (1783).

The Habeas Corpus Act was passed to prevent prisoners being kept an indefinite time in prison without trial. It provides that judges shall be compelled on the application of a prisoner to grant him a writ of *habeas corpus*, directing his

gaoler to produce him in Court and certify the cause of his imprisonment. Every prisoner must be indicted in the first term after his commitment, and tried in the subsequent term. A person once set free by order of the Court cannot be recommitted for the same offence. The suspension of the Habeas Corpus Act is only resorted to at times when danger is feared from sedition, to enable the leaders of sedition to be more easily dealt with.

The Septennial Act was passed in order to meet a temporary peril. It was passed in 1716, when a General Election was at hand, and it was feared that a Jacobite majority would be returned to Parliament. It provides that no parliament shall last more than seven years. If not dissolved by proclamation of the Sovereign within seven years of its election, it terminates by efflux of time, and a new election must be held.

The Act of Union with Scotland provided that the Parliaments of England and Scotland were to be united, that Scotwas to send 45 members to the House of Commons, and 16 peers, elected for life to the House of Lords. The laws and customs of each of the kingdoms were to remain unaltered, except as the united Parliament might from time to time determine.

The Peace of Utrecht put an end to the war of the Spanish Succession. It gave Spain and its colonies to the House of Bourbon, on condition that the Crowns of France and Spain should never be united. The other dominions of Spain were parcelled out among the Emperor, the Duke of Savoy, and Holland. England gained several colonies, and Louis XIV. bound himself to uphold the Protestant succession in England.

The Peace of Versailles put an end to the war between England on the one hand, and France and Spain on the other. These powers had attacked England while it had been busy in the war with its North American colonies. It resulted in the restitution by the various powers of many of the conquests made in the war, and exchanges of others.

The Act of Union of the Parliaments of Great Britain and Ireland added 100 Irish members to the British House of Commons. Thirty-two Irish representative Peers (including four prelates) were granted seats for life in the House of Lords.

3. What are the principal reforms since 1820 which have taken place regarding Religious Toleration, Child Labour, Education, and Freedom of Trade? Name the persons to whose advocacy they were chiefly due.

In 1829 the Test and Corporation Acts were repealed. These Acts practically prevented Dissenters and Roman Catholics from sitting in Parliament, serving in the Army and Navy, and gaining municipal honours. The repeal was chiefly brought about by the advocacy of the Whigs under Lord John Russell, and the incessant agitation of the Dissenters and the Roman Catholics in Ireland against them. It was carried into effect by the Government of the Duke of Wellington, who feared civil war in Ireland if justice was longer denied to the Roman Catholics. Since this date compulsory Church Rates have been abolished, Jews have been admitted to Parliament, Quakers and others who objected to the taking of an oath have been admitted into Parliament on making a declaration in lieu of the oath, and the Burial Act has been passed, giving Nonformists the right of burying their dead in the parish churchyard without the necessity of using the Church of England service at the grave side.

Since 1820 the minimum age at which children could be employed in factories has been raised from 8 to 10, and in 1891 to 11 years of age. In addition, the number of hours per day for which children can be employed has been limited, and the employment of children before certain hours in the morning and after certain hours in the evening has been prohibited. No child under the age of 13 can be employed, except as a half-timer, and the continuance of the employment is conditional on regular attendance at school. To be qualified to work as a half-timer, a child must have passed a standard of the Education Code, fixed by the Local Authority, with the consent of the Education Department, and pass a medical examination to test its fitness for employment. It is further enacted that no child under the age of 13 can be employed as a half-timer, although it has fulfilled the two conditions mentioned above, unless it can be shown that its wages are necessary for the support of the family. Between the ages of 13 and 14, a child can only be employed full time if it passes a certain standard. The various enactments dealing with child labour have been more efficiently carried out since the duty of inspection has been entirely assumed by the Home Office. It was to the advocacy of the late Earl of Shaftesbury that these enactments have been mainly due.

In 1833, Parliamentary Grants in aid of popular education were made. In 1839, the duty of administering these grants was transferred to a Committee of the Privy Council. Inspectors were appointed to see that the education given in the schools so aided was efficient. Grants were made in aid of school-building and to support colleges for the training of teachers. In 1870 an Education Act was passed, making education compulsory, and ordering the formation of School Board in places where there was not sufficient provision of school accommodation for every child of school age. In 1876 School Attendance Committees of the Boards of Guardians were constituted in districts where there were no School Boards, for the purpose of seeing that the compulsory clauses of the Education Acts were carried out. Full effect was given to this Bill in 1881, since which time education has been, in name at least, compulsory in England and Wales. Ten years later, school managers were given the option of abolishing school-fees, by the acceptance of an additional grant from Government in lieu of the fees hitherto charged. The persons to whose labours these changes are chiefly due were Lord Brougham, Sir J. Shuttleworth, Mr. W. E. Forster, and Lord Sandon.

A great step was taken towards freedom of trade by the Abolition of the Corn Laws in 1846. Since that time the duties on other imported articles of food and on articles of common necessity have been gradually reduced or entirely abolished. These changes have been chiefly brought about by the advocacy of Mr. John Bright, Mr. Cobden, and Mr. C. P. Villiers.

4. (*a*) State, as clearly as you can, the questions originally in dispute with the American Colonies, and point out the acts of the English Government which led to war.

The questions originally in dispute with the American Colonies were the imposition of a stamp duty, which was specially objected to, and the right of the mother country to impose taxes on the colonists without their consent. As the colonies sent no representatives to the British House of Commons, it was unconstitutional for that body to impose taxes on the inhabitants of the colonies. Two years after the ferment excited by the first attempt to tax the colonies had been allayed by the repeal of the Stamp Act, the Government imposed taxes on certain articles of consumption in America. The opposition raised to this measure induced the Government to repeal all the duties except that on tea, which they retained. It was the retention of this duty which led to war.

(*b*) Give a rough sketch of the steps by which our Indian Empire was gained, from the end of Clive's career to the present time.

Lord Cornwallis defeated Tippoo Sahib, who was forced to cede considerable territories to England. During the administration of the Marquis of Wellesley, a great part of the Deccan came into the power of the English. Sir Arthur Wellesley defeated the Mahratta chiefs at Assaye and gained great accessions of territory in the north of India. Assam, Aracan, and Tenasserim were annexed to the territories of the East India Company by Lord Amherst. At a later time Scinde was conquered by Sir Charles Napier.

(*c*) State what you know of the political principles and actions of Strafford, Clarendon, the younger Pitt, Lord North, Lord Russell, Lord Beaconsfield.

Strafford, from being one of the most resolute of the Parliamentary party, became a thorough absolutist. His aim was to place the monarch in a position of entire independence of Parliamentary control.

Clarendon, the chief adviser of Charles II. in the early part of his reign, was responsible for the Acts of Parliament known as the 'Clarendon Code.' The object of these Acts was to drive everyone into conformity with the doctrines and practice of the Church of England by placing the adherents of all other forms of faith under political and civil disabilities, and making it impossible for them to enjoy the practice of their own particular worship.

The younger Pitt was, with only a short interruption, Prime Minister from 1783 to 1806. Without accepting the doctrines of the more extreme party in the House of Commons, he was anxious to see reforms carried out, and, had it not been for the obstinacy of George III., he would have made an earlier settlement of many questions, such as that of Catholic Emancipation and Parliamentary reform. He did, however, secure great reforms in the finances of the country, and succeeded with a bill for the better government of India. The bill for the Union of the Parliaments of Great Britain and Ireland was passed while he was at the head of the Government. Pitt led us into the war with the French Revolutionists. He died while Napoleon I. was in the full tide of his military successes.

Lord North was the statesman during whose tenure of office the United States secured their independence. Lord North had not statesmanship enough to retreat at the proper time from the inadmissible position which the English Government had taken up, nor strength of character sufficient to influence his obstinate master, George III., in a right direction. After the first blood had been shed in the struggle between England and the American Colonies, Lord North offered ample concessions, which came too late. The year in which the War of Independence ended witnessed the break up of his ministry.

Lord John Russell was a Whig statesman who carried the bill of 1832 for Parliamentary Reform. He aided in the Repeal of the Corn Laws. Succeeding Sir Robert Peel as Prime Minister, he secured a reform of the navigation laws. At a later date he was responsible for the Ecclesiastic Titles Bill, which was passed under the influence of a panic, and speedily became a dead letter. Lord Russell, who lived to a great age, remained true to his early principles, but was too much inclined to believe that the reforms he had carried out were final.

Lord Beaconsfield, a statesman who died in 1882, was, as Mr. Disraeli, for many years the leader of the Tory Party in the House of Commons. He subsequently became Prime Minister, and was raised to the Peerage. He gave a new direction to the action of his party by leading it in the direction of making moderate reforms, for the purpose of staving off reforms of a more radical character. On more than one occasion, however, he propounded reforms of a more thorough character than those recommended by the party to which he was opposed. This was particularly the case with his Reform Bill of 1867.

(*d*) What do you understand by these terms :—Cavalier, Leveller, Presbyterian, Whig, Tory, High Church, Chartist, Jacobite, Hanoverian.

The Cavaliers were those who fought on the side of Charles I. during the Civil War.

The term 'Levellers' was first applied in James I.'s reign to the people who broke out into opposition to the numerous inclosures of common land which had been made. They levelled the fences which had been constructed, as a practical mark of their opposition. The name was subsequently applied to the ultra republicans of the Commonwealth period, who wished to establish an ideal equality between all men.

Presbyterians are a religious body who hold that the government of the Church by bishops is unscriptural. They commit the oversight of their religious matters to elders (Gk. *presbyteros*, elder). Presbyterians formed the majority of the members in the Long Parliament who were opposed to the policy of Charles I.

The Whigs were the party who from the reign of William III. opposed the extension of the royal prerogative, and laboured for reforms and for greater toleration in religious matters. The name has, of later years, been applied to the moderate, as opposed to the extreme, or Radical, section of the Liberal Party.

The Tories were the party who from the time of William III. opposed reforms, and endeavoured to maintain in all its fulness the connection between Church and State. The name Tory is now applied to the more extreme adherents of what is usually called the Conservative Party, which professes itself friendly to moderate reforms.

High Church is the name applied to the section of the Church of England which approximates, in doctrine and practice, nearest to the Church of Rome. They are distinguished from other sections of the Church of England by the importance they attach to the doctrines of the Apostolic succession of bishops and clergy, and of sacramental grace.

The Chartists were a party of radical reformers who came into existence in the present reign. They derived their strength and influence from the very unfavourable conditions under which the working-class population of this country lived some sixty years ago. They took their name from a Charter of reforms which they advocated. At one time the Chartist agitation appeared likely to lead to revolution, but it gradually broke up after the prosecution of its leaders. Many of the reforms advocated by the Chartists have since passed into law.

The Jacobites were the adherents of the deposed Stuarts. The word is derived from *Jacobus*, the Latin for 'James.' After the unsuccessful rebellion of 1745, Jacobitism gradually died out.

The Hanoverians were those who defended the title of the first two Georges against the Jacobites. With the accession of George III., who was by language and temper a thorough Englishman, the term ceased to have any meaning.

(*Answer two out of the four sections of this question.*)

5. Give the personal character of James I., and contrast the characters of Charles I. and Charles II. with it. What principles regarding government had Charles I. inherited from his father? Name the chief actions by which he united the Puritan and the Parliamentarian spirits against him.

James I. possessed no strength of character or personal courage. Both these failings combined caused him to be regardless of the honour of the country he ruled over, on occasions when it was necessary for him to make a firm stand. He had been carefully educated, particularly in the points of controversy between Roman Catholics and Protestants, and between the different sections of Protestants. His great learning, of which he was uncommonly vain, had not made him wiser, so that he was not untruthfully called 'the most learned fool in Christendom.' He had a weakness for favourites, who were all men of unworthy character, was regardless of his personal dignity, and incapable of gratitude. Like his son, Charles I., his word could not be relied on.

Charles I., unlike his father, was a man of great personal courage. In his domestic relations he was a good husband and father, but, as a king, he was obstinately attached to opinions and practices which were not in accord with the spirit of the times in which he lived. The worst feature in his character was his duplicity, and it may be said that it was this which led to his untimely and unhappy death. On more than one occasion, he disgusted his friends as much as his enemies by his double dealing.

Charles II. was obstinately attached to the ideas of the kingly prerogative which had cost his father so dear. He also inherited his father's personal courage, and he possessed, as few kings have possessed, the art of condescending to his subjects in such a way as to endear them to him, and inspire them with a feeling of loyalty to himself. Taught by his father's misfortunes, he did not attempt to insist on prerogatives which he found would not be tolerated. The worst feature in his character was his immorality. To the indulgence of sensual passion he was ready to sacrifice, and did sacrifice, his personal honour and the honour of his country.

Charles I. inherited from his father the idea that kings were divinely appointed, and that consequently they owed their subjects no account of their actions, for which they were responsible only to God. From this idea followed, as natural consequences, the ideas that the monarch might do as he pleased, and that passive, unthinking, uncriticising obedience was due to him from his subjects, whatever his actions might be.

The chief actions by which Charles I. united the Puritan and the Parliamentarian spirits against him were the persistent persecution and cruel punishment of all who openly expressed their dissent from the State religion or who openly criticised his unconstitutional actions, his steady support of his unworthy favourite Buckingham and of his tyrannical ministers Laud and Strafford, his resistance to all projects of reform pressed on him by Parliament, and his frequent breaches of faith with regard to reforms he had professed to accept, and of the persistence with which he levied and collected taxes he had himself imposed without the consent of Parliament.

6. What do you know of the Duke of Buckingham (in the reigns of James I. and Charles I.), Sir John Eliot, Laud, Prynne, Fairfax, Montrose?

The Duke of Buckingham, as George Villiers, first appeared at the Court of James I. in the year 1615. After the fall of James's first favourite, Robert Carr, his place was taken by Villiers, who was raised by rapid steps in the peerage to be Duke of Buckingham. He was a man of unbridled insolence and vanity. His open and shameless immorality disgusted all sober-minded people. Having an eye to the future, he ingratiated himself into the favour of Prince Charles, James's son. He accompanied Charles on a visit to the Spanish Court in search of a bride, but he disgusted the Spaniards by his upstart insolence and licentiousness. When Charles came to the throne, Buckingham became obnoxious to the patriotic party by the evil influence he exerted on the king. The second Parliament of Charles presented articles of impeachment against him. To save his favourite, Charles dissolved the Parliament. He was then entrusted with the command of a fleet and army which had been raised for the purpose of compelling the French Catholics to raise the siege of La Rochelle. The expedition ended in disaster. Charles had to prorogue his third Parliament to save Buckingham from impeachment. He was entrusted with the command of a new expedition to La Rochelle, and was preparing to set sail when he was stabbed by an assassin, John Felton.

Sir John Eliot became distinguished in the first Parliament of Charles I. as a leading opponent of the king's unconstitutional government. He was appointed one of the managers of the impeachment of Buckingham, which was commenced by Charles's second Parliament. For this he was committed to the Tower, but was released on the refusal of the Parliament to proceed with its business. He took a leading part in the scene in Charles's third Parliament when the Speaker was forcibly held down in his chair whilst the remonstrance of the Commons was read. He was imprisoned for refusing to answer in the Court of Queen's Bench for his conduct on this occasion. As he refused to give sureties for his good behaviour, he remained in prison, where he died.

Laud was the leader of the Arminian and High Church sections of the Church of England in the reigns of James I. and Charles I. Charles made him Archbishop of Canterbury, and it was under his influence that Charles embarked on a course of religious tyranny. Both in doctrine and in practice he approached very near the Church of Rome. He was thought to be desirous of bringing about a reconciliation between the Church of England and the Roman Church. He was committed to prison by the Long Parliament. After being imprisoned for several years, he was proceeded against by bill of attainder, condemned, and executed.

Prynne was a barrister of Lincoln's Inn who wrote a book condemning dramatic performances, music, and dancing. The book was condemned by the Star Chamber as a seditious libel. Prynne was punished by being heavily fined, condemned to stand in the pillory at Westminster and Cheapside, to have an ear cut off at each place, and to be imprisoned for life. This cruel sentence only roused public sympathy for him, and did not daunt his Puritan zeal. He was released by order of the Long Parliament, and at a later date was commissioned by that body to collect evidence for the articles of impeachment against Laud.

Sir Thomas Fairfax was the son of Lord Fairfax, one of the Parliamentary generals in the first part of the Civil War. He was appointed general of the Parliamentary forces after the remodelling caused by the passing of the Self-denying Ordinance. He took a leading part in the remainder of the Civil War, but did not participate in the trial and execution of the King.

Montrose was the general who fought for the cause of Charles I. in Scotland. He gained several victories, which, however, he was not able to utilise. He was finally defeated by the Covenanters at Philiphaugh. When Prince Charles, afterwards Charles II., made an attempt to recover his father's kingdom, Montrose again raised the royal standard. Charles, who for political reasons had accepted the Covenant, disavowed Montrose, who was taken prisoner and executed under a bill of attainder passed against him in 1644.

7. What events connected with the Civil War took place at Nottingham, Oxford, Taunton, Bristol, York, Newcastle, Dunbar, Worcester?

At Nottingham Charles I. raised the Royal Standard on the outbreak of the Civil War.

Oxford was the headquarters of Charles I. during a great part of the Civil War. Here he summoned a Parliament, which the majority of the Peers attended, but from which the Commoners mainly held aloof. The king was besieged for some time in Oxford, whence, when the fall of the town seemed imminent, he escaped in disguise, and fled to the head-quarters of the Scots at Newark.

Taunton was captured by Essex in the earlier part of the Civil War.

Bristol was taken by Prince Rupert as a result of a decisive victory gained by the Royalists, near Devizes, over Sir William Waller.

York was besieged by Lord Fairfax and the Scots. The approach of Prince Rupert to its relief caused him to raise the siege and march against the Royalist army. The Parliamentary forces gained the day at Marston Moor, and York surrendered to Fairfax.

The Scotch took Newcastle after the Battle of Marston Moor. The result of this was to secure the North of England for the Parliament.

At Dunbar the forces of the Scotch, arrayed in support of Prince Charles, afterwards Charles II., were defeated by Cromwell.

At Worcester, the attempt of Prince Charles to gain his father's crown received a crushing blow. His army was utterly defeated by Cromwell.

8. Explain the terms:—National Covenant, Solemn League and Covenant, Eastern Association, New Model, Self-denying Ordinance, Delinquent, Commonwealth, Independent.

The National Covenant was a document by which the Scotch of all classes bound themselves to maintain the reformed faith against the errors of Popery.

The Solemn League and Covenant was an engagement entered into between the English Parliament and representatives of the Scotch Covenanters. The Scotch bound themselves to invade England, on condition that their own Church should be preserved in its purity and freedom, and that the English Church should be reformed according to the Word of God.

The Eastern Association was one of many combinations for mutual defence entered into in various parts of England at the time of the outbreak of the Civil War. The area of its activity extended over the counties of Norfolk, Suffolk, Essex, Cambridge, Herts. Under the leadership of Cromwell, it became the strongest of the various Associations which were formed.

The New Model was the name given to the army as reorganised by Cromwell. What he looked for in the recruits he enrolled was a profession of religion in addition to ordinary soldierly qualities. Thus remodelled, the Parliamentary army entered on a series of victories which led to the utter overthrow of the Cavaliers.

The Self-denying Ordinance was a measure passed by Parliament at the instigation of Cromwell, enacting that no member of either House should hold a command in the army or a civil office. The object of this measure was to get rid of the incompetent commanders of the Parliamentary army.

The Delinquents were Royalist partisans who had assisted Charles in collecting illegal taxes, or had concurred in sentences of the Courts of Star Chamber and High Commission. When the power passed into the hands of the Parliament, these 'delinquents' were treated with great rigour.

The Commonwealth is the name given to the Government of England during the eleven years which intervened between the execution of Charles I. and the restoration of the Stuarts. The name is sometimes restricted to the period preceding the election of Cromwell as Protector.

The Independents were a religious party who rejected the idea of a National Church, and insisted on the right of each congregation to freedom of faith and worship. Cromwell was the leader of this party.

ELEMENTARY LESSONS IN AGRICULTURAL ZOOLOGY.

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CHAPTER II.—INSECTIVORA (INSECT-EATING MAMMALS) AND CHEIROPTERA (BATS).

INSECTIVORA, or Insect-Eating Mammals, as we might suppose from the minuteness of the animals on which they feed, are in nearly every case below the medium size. Insects, worms, and snails form their customary food, and only one species, the hedgehog, *Erinaceus europaeus*, seizes for its prey such small animals as chickens, lizards, and frogs. All the insectivora are plantigrade, *i.e.* they walk on the soles of their feet, not on the under side of the toes like the dog and cat. They have not much occasion for sight, and consequently their eyes are, as a rule, very badly developed. On the other hand, their teeth form most formidable weapons. Not only are the incisors extremely sharp, but the back teeth, which are completely covered with enamel, are remarkable for their pointed crowns. Moreover, their teeth are so arranged that when their mouths are closed the upper teeth fit into the spaces between the lower teeth, and the lower teeth fit into the spaces between the upper teeth. This arrangement causes the speedy mastication of any insect which

may happen to be between the jaws, for the shutting of the mouth forces all the points of the back teeth into its body.

The first family belonging to this order, the Shrews (*Sorex*), bear a very strong resemblance to one of our domestic plagues, viz., mice. Their small slender bodies are covered with soft hair. They have small eyes, long pointed muzzles, and rather long tails. In the hinder part of their body are two glands secreting musk, of which they smell strongly.

The Common Shrew, *Sorex vulgaris*, is of a blackish-brown colour, and differs mainly in its larger size from the Lesser Shrew, *Sorex pygmaeus*, which is only about two inches in length. The Water Shrew, *Sorex fodiens*, is black, and is nearly twice the size of the Lesser Shrew. The Common Shrew and its tiny cousin are of the greatest service to the farmer and gardener. Not only do they destroy an enormous quantity of insects injurious to field and garden crops, together with their larvæ, but they also keep down snails, worms, and field voles. The Water Shrew is also of service in this way, but against the good it does must be set the fact that it is one of the worst enemies of the pisciculturist, devouring small fish, and eating out the eyes and brains of the larger ones. The great mortality noticeable among shrews in the early autumn is probably due to insufficiency of food.

The Mole, *Talpa europaea*, is easily recognised. Its thick cylindrical body is covered with shining black fur, among which its small eyes are scarcely visible, and it has no external ears whatever. The auditory opening, too, can be completely closed by a fold of skin. The mole is essentially a digging animal, and for this purpose its legs are short, the fore legs being also broad and spade-like with broad digging claws. All sorts of soil inhabited by insects and earth-worms are frequented by moles, given two conditions, that they be not too stiff, and that they are sufficiently coherent to admit of passages being dug in them. The heaps of earth thrown up by moles form a ready indication of their presence. The nest, which is lined with dried grass or leaves, is always found under a large heap, sometimes in the open field, but more usually hidden under tree roots, walls, &c. A passage always runs from it to the mole's hunting ground. This passage forms a tube varying from 100 to 160 feet long, and can be readily detected by a depression in the soil, for the mole in forming it does not throw out the soil, which becomes laterally depressed. The habits of the mole are very interesting. During the time it is not hunting for insects, it sleeps in its nest. Three times every day it seeks its food, in the early morning, at mid-day, and before sunset in the evening. It is said to consume every day more than its own weight of wireworms, grubs, snail-embryos, earth caterpillars, mole crickets and their larvæ. During the summer the passages dug by this animal are near the surface, for larvæ and worms are then found in the uppermost layer of earth. In winter it is obliged to dig them much deeper, for larvæ and worms then withdraw further into the soil. The mole is not a hibernating animal. Its young, which vary from three to seven in number, are born in the summer, during May, June, or July. The mole, though very useful to the farmer as a devourer of insects, must in some respects be reckoned among his foes, for it roots up plants as it makes its heaps, and the molehills in hay fields and corn fields are a nuisance at harvest time. Almost any kind of flesh is eagerly devoured by captive moles, and if two moles are confined together without food the stronger will infallibly devour the weaker.

The Hedgehog, *Erinaceus europaeus*, derives its name from rolling itself into a ball covered all over with prickles at the approach of danger, the dorsal integument being brought downwards and inwards over the head and tail by the action of special muscles. During the day it sleeps in its hiding place, which is situated in such places as the side of a ditch, a hedge, or under heaps of brushwood. At night it goes on the hunt, preying more especially on field voles, but also attacking eggs, small birds, lizards, adders, frogs, cockchafers, earth worms, and field snails. Occasionally it has been known to regale itself on fallen fruit and juicy plant roots and underground stems.

The *Cheiroptera*, like the *Insectivora*, feed on insects, and have their teeth so formed that the upper teeth fit into the spaces between the lower teeth, and *vice versâ*, when the mouth is closed. They are easily recognised by the very characteristic modification of the fore limbs into a flying apparatus. The bones of the fore arm and the bones of the hand and fingers, except the thumb, which possesses a sharp claw, are very long, and between the long fingers, between the fore and hind limbs, and between the two hind legs there is an elastic membrane, which serves them both for flight and touch. A delicate sense of touch is also seated in the skin of the ears, which are sometimes of very considerable size, and in the case of the leaf-nosed bats in the membranous flaps which occur on the nose and lips. Since bats sleep during the day their sight is ill developed. When a bat is on the ground it rests on all fours with the knees directed upwards, and its walk is an awkward shuffle. During the winter they hibernate in chimneys, hollow trees, ruins, and other places of concealment. Bats are of great service to the farmer, for they are very voracious, destroying large quantities of night flying moths, whose caterpillars are very injurious to crops. They also devour spiders.

To recapitulate, we have seen that:—

1. The natural order of mammals termed *Insectivora* derive their name from the fact of their feeding on insects. They comprise Shrews, Moles, and Hedgehogs.

2. Shrews have some resemblance to mice, from whom they are easily distinguished by the musk secreted by two glands in the hinder part of their body. The Common Shrew, the Lesser Shrew, and the Water Shrew destroy large quantities of noxious insects, snails, worms, and field voles, though the Water Shrew is very injurious to fish breeding.

3. The Mole has broad digging claws, small eyes which are scarcely visible, and no external ears. Hence it is popularly supposed to be both blind and deaf. It digs subterranean passages, and is a great foe to wireworms, grubs, earth caterpillars, mole-crickets and their larvæ. On the other hand it sometimes ruins plants by rooting them up as it makes its heaps, and mole-hills in hayfields and cornfields are a nuisance at harvest time.

4. The Hedgehog is easily recognised by its habit

of rolling itself into a prickly ball when molested. Its food consists principally of field voles, eggs, small birds, lizards, adders, frogs, cockchafers and their larvæ, field snails, and earth worms.

5. The natural order of mammals termed *Cheiroptera* also feed on insects, but are readily distinguished from the *Insectivora* by their flying apparatus, which is formed by the modification of their fore limbs. They are of great service to the farmer, devouring a great quantity of night flying moths whose caterpillars are injurious to agriculture.

MODERN EDUCATIONAL REFORMERS.

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No. XVII.—JEAN GIRARD.

To-day Swiss schools and Swiss teachers are regarded with pride by the inhabitants of the sturdy little republic, and with admiration by the world at large. Nor does a closer inspection lend disenchantment to the view: on the contrary, a visit to a typical Swiss school cannot fail to interest and instruct the enquiring student of educational problems. The state of affairs educational has not always been so satisfactory, for a century ago chaos was the order of the day in Switzerland, as elsewhere, in the matter of popular education. And the evolution of order out of this chaos and void was the peculiar work of a small band of devoted men, amongst whom stand out most prominently Pestalozzi and Jean Girard.

It was whilst sitting on the shores of blue icy Lucerne in the shade of the world-famed Schweizerhof Hotel and with grim Pilatus standing out boldly in front of us across the ample bosom of the lake, that we learnt how great is the fame of 'le père Girard' in the land where he lived and laboured. In the opinion of our Swiss informant, who was well qualified to judge, the good achieved by Girard well-nigh equals that of Pestalozzi himself, so far as concerns the common school education of Switzerland. Whilst unable to accept this as literally true, we must concede that Jean Girard was a tried and true reformer who through good and ill repute steadfastly endeavoured to improve the condition of the popular education of his fatherland, upon which he has left so indelible a stamp.

By way of insight into the condition of schools and teachers in the pre-Pestalozzian period, our friend repeated to us the somewhat amusing and quite amazing account of the appointment of Kruesi, one of Pestalozzi's students, to the honourable post of master of the school of Gais. This was in 1793. Kruesi was, at the age of 18, a pedlar by trade. Whilst in the active pursuit of this occupation he casually heard of the vacancy and was recommended to try for it, notwithstanding the fact that he was totally illiterate, seeing that 'he could easily learn what a schoolmaster should know.' This decided him, and accordingly he set to work to accomplish his design upon the village school. The test consisted mainly in writing out the Lord's Prayer. As our readers are probably well aware, it is customary, in German, to make the initial letter of every noun a capital. Kruesi had noticed that such letters were used. Why, he did not know, so he presumed that they were intended merely as ornaments, and consequently introduced them here and there, sometimes in the middle as well as at the beginning of words! He had but one competitor, and this gentleman retired crestfallen, for, although he excelled Kruesi in reading, his writing was nowhere beside that mentioned above, and, most important of all, the house of Kruesi was better fitted for a school than that of his rival, so that in the end the ingenious interpolator of capitals became the master of Gais school. To have triumphed in the teeth of such a discouraging state of affairs was no mean accomplishment, and it is from a reflection of what preceded rather than of what has succeeded the work of a reformer that we are able in some measure to estimate him at his true worth. To Pestalozzi something like justice has been done even in England, but since it is to be doubted whether the average English teacher has ever heard the name of Girard, it will not be unprofitable to include him in our knot of reformers.

Jean Girard was born at Fribourg in 1765, where, eighty-five years later he died and was buried. He was introduced very early to practical teaching, being the assistant of his mother in the education of her fourteen children. Become sixteen years of age he joined the Grey Friars at Lucerne, and having completed his novitiate he taught in divers convents. The natural trend of his thoughts was in the direction of educational matters, to which was doubtless due his study of Kant, the great German psychologist. In 1798 appeared his first work on the subject of his thoughts, viz., 'A Scheme for the Education of all Helvetia.'

In 1804, the primary school at Fribourg was entrusted to the care of the Grey Friars, and Girard was happy in being chosen 'prefect of studies' and director of the general economy of the school. Ten years passed by in which the prefect busied himself ceaselessly until he had perfected his system to such an extent as to deserve and receive honour even in his own country, as the following encomium will show:—'He had trained a body of youth the like of which perhaps no city in the world could furnish. It was not without a profound emotion that the friends of humanity contemplated a spectacle so new and so touching. That ignorant and boorish class, full of prejudices, which everywhere abounds, was no longer met with at Fribourg. The young there developed graces of an amiable deportment which were never marred by anything disagreeable in tone, speech, or manner. If, seeing children approaching you covered with rags, you approached them thinking that you were about to encounter little ruffians, you were wholly surprised to hear them reply to you with politeness, with judgment, and with the accent which bespeaks genteel manners and a careful education. You will find the explanation in the school, where you observe the parts where these same children exercise by turns, as in playing, their judgment and their conscience. Three or four hours a day employed in this work gave the young that intelligence, those sentiments and those manners which delighted you.'

The Jesuits, wishing for a monoply of education,

ever regarded a successful preceptor outside their ranks—be he Protestant or Catholic—with marked disfavour. It was not long ere the machinations of this powerful body were directed against the 'père Girard,' and ultimately, as a result of their intrigues, the Grey Friars lost the control of the Fribourg school, and Girard sorrowfully gave place to a less worthy and less enthusiastic man. This took place in 1818. Having lost the occupation which gave colour to his life at Fribourg, the good father could no longer endure the place, but bent his steps once again in the direction of Lucerne, where he remained until 1823, and where his memory is still affectionately preserved, of which we had ample testimony. Here he taught philosophy until the year 1834, when Fribourg again became his resting-place. The concluding years of his life were spent in seclusion, the fruits of which will long remain to bear witness to the fact that the last days of his life, like those of his youth and manhood, had been spent in the cult of education. These are 'L'Enseignement Régulier de la Langue Maternelle' (Systematic Teaching of the Mother Tongue), published at Paris in 1844, and 'Cours Éducatif de la Langue Maternelle' (Educative Course in the Mother Tongue), which followed in 1846. The former of these two works was crowned by the French Academy, and in France and Italy the influence of the Père Girard has been all powerful in determining what shall be the character of their principles and methods. What, then, was the method, and what the principles for which we have to thank the Swiss Reformer? When a teacher, giving a verb and a noun, gets his children to join them together into a sentence, as 'Dogs bark': when he encourages them to expand this sentence by the addition of qualifying words or phrases, as 'Big and little dogs bark loudly at night,' he is teaching grammar in the Girardian vogue, since it was the aim and purpose of the 'Father' to insist upon inductive teaching, so that we have ventured to describe him as the apostle of the inductive method. Like Herbert Spencer, he has no opinion of the 'rule-taught youth'; to him the examples are the main thing, from which, being present, the intelligence of the child will in due season abstract the concrete, and build up the rule for itself. To overrate the importance of this mode of procedure is impossible, and it is a significant fact in support of this that, since the time of Girard, increasing importance has been, and is being, attached to inductive teaching in all works on school method.

Another peculiarity, equally creditable to the worthy father, was his belief that all subjects should be made vehicles of moral teaching. Here is an example of his 'moral arithmetic' culled from Compayré's 'History of Pedagogy:' '*A father had the habit of going every evening to the dram shop, and often left his family without bread. During the five years that he led this life, he spent, the first year,* 197 *francs, the second* 204 *francs, the third* 212 *francs, and the fourth* 129 *francs. How many francs would this unfortunate father have saved if he had not had a taste for drink?*' This is a conspicuous example of zeal run mad, since the result of such a thrusting of morality down the children's throats in season and out of season would result in a loathing of the very name of morality. When it is remembered that all subjects were to be treated in the same revolting way, it does not need much argument to prove that speedy nausea would be the result of such injudicious teaching. As Payne so aptly says, 'The misuse of a good thought is seen in the attempt of the Père Girard to give a distinct moral value to every school exercise. It is the verdict of experience that the moral value of science is greatest when it is taught simply as science, and that the direct teaching of ethics should be conducted on an independent basis.

It was Girard who, in 1809, was sent to enquire into the conduct of Pestalozzi's institute at Yverdun, at the time when Pestalozzi had allowed the mechanical Schmid to override his theories and methods. It was not long before Girard found that the preponderance given to mathematics, in which subject Schmid excelled, was out of all proportion to the importance of that branch of learning either from culture or from ability.

'I made the remark,' he writes, 'to my old friend Pestalozzi that the mathematics exercised an unjustifiable sway in his establishment, and that I feared the results of this on the education that was given.' Whereupon he replied to me with spirit, as was his wont, 'This is because I wish my children to believe nothing which cannot be demonstrated as clearly to them as two and two make four.' My reply was in the same strain,—'In that case, if I had 30 sons, I would not entrust one of them to you, for it would be impossible for you to demonstrate to him, as you can that two and two make four, that I am his father, and that I have a right to his obedience.'

Here the father was right, and Pestalozzi undoubtedly wrong. This does not prevent Girard from gratefully admitting that his insight into the methods of Pestalozzi gave him the clue to his own system; and that his views were generally correct, and greatly in advance of his age, no one will doubt who reads the purport of Villeman upon the school at Fribourg: 'Where the period of instruction is necessarily short and its object limited, *a wise choice of method is the thing of first importance*, for upon this choice will depend the education itself. If the method is purely technical, if its exclusive object is reading, writing, and the rules of grammar and computation, the children of the common people will be *poorly instructed and not educated at all.* A difficult task burdens the memory without developing his soul. A new process is placed at his disposal, one workshop more is open to him, so to speak; *but the trace left by the instruction will not be deep*, will sometimes even be lost through lack of application and exercise, and *will not be acted on the moral nature. That only is then the real people's school in which all the elements of study serve for the culture of the soul, and in which the child grows better by the things which he learns, and by the manner in which he learns them.*'

The concluding words of the last section are sufficient proof of the soundness of Girard's contentions, and, if he did ride his hobby inordinately, judgment upon failings, 'leaning to virtue's side,' is, according to the acknowledged canons of good taste and feeling, of the mildest possible description.

A trait in the character of our Reformer which must not be left unrecorded here was his extreme toleration. We are told that he was deeply concerned when it was insisted in his hearing that none but Catholics could see salvation. Running to his mother with tears in his eyes he entreated a more

liberal judgment at her hands, it being intolerable to him that the Protestants with whom he held daily converse should be in danger of damnation, and it is conceded that his mother's assurance as to the falsity of the dogma in question, not only comforted him then, but coloured the whole of his conduct as a priest, for he declared that he held to his mother's theology, in proof of which may be cited the fact that his drawing-master at Fribourg was a Protestant, and that all his teachers there were laymen. To this was due the hatred and persecution of the Jesuits, and for this we shall the more honour and respect the sturdy Swiss, placing him not far below Pestalozzi because of his championship of education as opposed to instruction, because of his advocacy of the inductive method, because of his recognition of the all importance of moral instruction, because of his livelong devotion to the cause of education, as well as for the manly stand he made for toleration and largemindedness, whereby we are compelled to acknowledge that here was not only a true teacher but a true man, a good and faithful servant meriting perpetual remembrance.

LONDON SCHOOL BOARD SCHOLARSHIP EXAMINATION, DECEMBER 1894.

The opportunities for children in elementary schools to proceed to higher stages in a course of education are becoming more numerous. Through the Technical Education Board and the School Board for London, some hundreds of scholarships are provided annually to enable the most promising pupils in elementary schools to enter secondary schools. In December last, examinations were held to determine the award of seventy-eight scholarships, which the London School Board had the power to dispose of.

The increased facilities for gaining scholarships will naturally lead to more candidates offering themselves at the examinations, and there will also be a demand for information respecting the conditions of the competition. One very important matter for teachers who may wish to enter scholars for examination, is the scope and range of the examination tests, and nothing can afford more trustworthy guidance on this matter than the papers of questions given. For this reason we have, from time to time, placed before our readers the sets of papers which have been given at the examinations, and we are now able to add to the series the questions set in December.

The examinations are three in number. First, the Preliminary, which includes three papers on the subjects of Arithmetic, English Grammar and Composition, History, and Geography, for all the candidates, and a further test in Drawing for the boys, and in Needlework for the girls. Next the Intermediate Examination, in which all who obtain a certain satisfactory proportion of marks in the Preliminary are allowed to compete, and each candidate may select two of the following subjects:—Drawing (for girls only), Animal Physiology, Elementary Science, Mechanics, Chemistry, Algebra, Euclid, Domestic Economy, Botany, and French. Lastly, the Final Examination, for those who have obtained a certain number of marks in the two previous examinations. This is for the most part an oral examination, and consists of reading aloud, answering questions on the subject-matter of the passage read, and on other topics suitable for gauging the intelligence and general knowledge of the candidates. It includes tests in Writing, Spelling, Punctuation, and Mental Arithmetic, and an exercise is given in reproducing the substance of a passage read over twice.

The Preliminary Examination occupied two days, the 4th and 5th of December, and was attended by nearly 300 candidates, rather more than a third of whom were girls. 112 boys and 52 girls reached the standard which entitled them to enter the Intermediate Examination, which was held on the 14th and 17th of December. 71 boys and 44 girls were selected for the Final Examination, which also occupied two days, the 20th and 21st. The order of merit of the competitors was determined by the aggregate marks each obtained in the three examinations, and this determined the award of the 52 scholarships for boys and the 26 for girls.

For the convenience of teachers who may use the papers to test their pupils, we append the answers to the questions in Arithmetic and Algebra, and to the numerical examples in Mechanics.

PRELIMINARY EXAMINATION.

ARITHMETIC.

Time allowed—3 *hours.*

[All the working must be shown.]

1. Divide thirty-nine millions three hundred and forty-two thousand one hundred and fifty-four by 423.

2. If telegraph posts are placed 66 yards apart, and a train passes one every 3 seconds, how many miles an hour is the train running?

3. How many times is 7 gall. 5 pt. contained in 20 bus. 5 gall. 3 pt.?

4. Divide £5 9s. 10¾d. between two men so that one may receive half as much again as the other.

5. Find, by the method of factors, the highest common factor of 825 and 1320.

6. If a kilomètre be taken to be $\frac{5}{8}$ of a mile, reduce 17 miles 6 fur. 82 yds. 1½ ft. to kilomètres.

7. Simplify $\frac{5 - 2\frac{1}{8} \text{ of } 1\frac{3}{5}}{\frac{7}{8} \text{ of } 1\frac{3}{5} - \frac{11}{40}} - \frac{2\frac{1}{8}}{\frac{1}{8} + 1\frac{3}{8}}$.

8. Divide the product of 1·23 and ·0059 by ·005.

9. Add together 3½ of a crown, $\frac{11}{20}$ of ten shillings, $\frac{17}{84}$ of a guinea, 1·375 of 20s., and ·2$\dot{3}$ of ten shillings.

10. Assuming that 96 cubic feet of air are allowed to each child, what is the greatest number of children that should be allowed in a schoolroom which is 30 ft. long, 15 ft. wide, and 13 ft. high?

11. Find (by Practice) the value of 16 oz. 6 dwt. 20 gr. at £3 17s. 6d. per oz.

12. Show, in the shortest way possible, that the simple interest on £625 for 8 months at 4½ per cent. per annum is equal to that on £1,875 for 4 months at 3 per cent. per annum.

13. Find the present value of £68 13s. 4d. due 9⅜ months hence at 3½ per cent. per annum.

14. What will it cost to cover the walls of a room with paper ⅝ yd. wide at 2½d. per yard, the length of the room being 20⅜ ft., and the width 11½ ft., and the height 12½ ft.?

15. By selling tea at 2s. 4d. per lb. a grocer gains one-seventh of his outlay; what profit per cent. will he make by selling the same tea at 2s. 6d. per lb.?

16. A train having to perform a journey of 250 miles is obliged, after 103 miles, to reduce its speed by one-fifth. The result is that the train arrives at its destination 1 hour 10 minutes behind time. What is its ordinary rate?

ENGLISH HISTORY AND MODERN GEOGRAPHY.

Time allowed—3 *hours.*

1. Write short historical notes about *three* of the following:—*Poor Law, Statute of Mortmain, Habeas Corpus Act, Declaration of Independence, Self-Denying Ordinance.*

2. Why did the barons fight against Henry III.? What changes in the mode of governing the country were introduced by their leader?

3. Name, with dates, the chief battles (*a*) between English and French armies, and (*b*) between English and Scotch armies, from the accession of Edward I. to the death of Elizabeth. Give some details with regard to one from each group.

4. State briefly what you know about—
   (*a*) The feudal system;
   (*b*) The trial of John Hampden;
   (*c*) Monmouth's Rebellion.

5. What were the chief points in dispute between Charles I. and his Parliament? Give some account of his attempt to arrest the five members.

6. Write short notices (about five lines each) of *three* of the following:—Sir Francis Drake, Archbishop Laud, Cardinal Pole, Lord Clive, William Pitt, Richard Cobden.

7. Explain the terms—*isthmus, fiord, iceberg, alluvial deposits, zenith, isothermal line.*

8. Explain, introducing diagrams, why the day is always twelve hours long at places on the equator, and why in England it varies in length with the seasons.

9. Arrange the following towns in order of population, and state for what each is noted:—Birmingham, Dublin, Glasgow, Plymouth, Manchester, Belfast, Edinburgh, Bristol, Cape Town, Melbourne, Liverpool, New York, Paris, Bombay.

10. What are the chief exports of (*a*) England, (*b*) India, (*c*) Russia, (*d*) British North America, (*e*) China?

11. Compare the advantages offered to emigrants in any *two* selected British Colonies; *or*, write a geographical description of New Zealand.

12. Draw an outline map of India, *or*, Italy, showing the chief physical features, and position of ten large towns.

English Grammar and Composition.

Time allowed—3 hours.

1. Parse fully the following sentence:—
'It becomes the throned monarch better than his crown.'

2. Analyse the following passages:—
(*a*) 'Regions Caesar never knew,
Thy posterity shall sway.'

(*b*) 'Breathes there the man with soul so dead,
Who never to himself hath said,
This is my own, my native land!
Whose heart hath ne'er within him burned,
As home his footsteps he hath turned
From wandering on a foreign strand!'

3. Give the plurals of—*goose, deer, brother, appendix, phenomenon, axis, die;* and the feminine of—*lad, nephew, actor, hero.* Compare *late, sorry, much, beautiful.*

4. What is a conjunction? Name two kinds of conjunctions, and give three examples of each.

5. What do you understand by the term Auxiliary Verb? Conjugate the verbs *shall* and *ought* as far as you can without using other auxiliaries.

6. Explain the force of the prefixes in *unfit, submerge, disconnect, retrograde, translate;* and of the suffixes in *friendship, owlet, balloon, twenty.*

7. Write short sentences to show the different meanings each of the following words may have—*that, die, lay.* In each case parse the word you illustrate.

8. Paraphrase the following passage (using only simple words and phrases) so as to show clearly you understand the meaning:—
'It was about the lovely close of a warm summer day,
There came a gallant merchant-ship full sail to Plymouth Bay;
Her crew hath seen Castile's black fleet beyond Aurigny's Isle,
At earliest twilight on the waves lie heaving many a mile.
At sunrise she escaped their van by God's especial grace!
And the tall *Pinta*, till the noon, had held her close in chase.
Forthwith a guard at every gun was placed along the wall;
The beacon blazed upon the roof of Edgecumbe's lofty hall;
Many a light fishing-bark put out to pry along the coast;
And with loose reign and bloody spur rode inland many a post.'

9. Correct the following sentences, giving your reasons:—
(*a*) My older brother is two inches taller than me.
(*b*) I am neither a good runner on grass or a cinder path.
(*c*) He has brought this memoranda, and not before it was wanted either.

10. In the following passage supply the necessary capital letters, and put in the stops and inverted commas where necessary:—
it is said that the night before they were to pass into macedonia brutus was sitting alone in his tent when he saw the figure of a man before him who art thou he asked and the answer was i am thy evil genius brutus i will meet thee again at philippi.

11. Write a short essay on *one* of the following subjects:—
(*a*) The evils of obstinacy.
(*b*) The Tower Bridge.
(*c*) 'To rise early, to live soberly, to be really diligent, are the sure means of success.'
(*d*) 'He who pursues two hares catches neither.'

Needlework.

Time allowed—2 hours.

Directions. [To be read carefully through by the Candidate before beginning work.]
The calico marked A is for Exercise A.
The stocking web and the coarse pink and blue cotton are for Exercise B.
The calico and tape marked C are for Exercise C.
Exercise A must be fully completed before Exercise B is begun, and no marks will be given for Exercise C, unless Exercises A and B are both finished.

Questions.

Exercise A.—Run and fell together the two pieces of calico; turn down and tack a hem, and work on it a button-hole as for the front of a shirt.

Exercise B.—Plain darn a hole. The hole itself not to be smaller than a threepenny bit.

Exercise C.—Show how the armhole of a pinafore or a baby's shirt can be strengthened with a piece of tape.

Drawing.—Boys.

Time allowed—2 hours.

Freehand.

Candidates are required to copy in pencil carefully the printed example, increasing the height about two inches, and the width in proportion. No ruling or measuring of any kind is allowed.
[The example was a floral design of about the degree of difficulty of the exercises set in the Government Science and Art Examinations for Seventh Standard or for Second Grade, and the dimensions were about 5 inches by 3 inches.]

Geometrical.

1. Construct a square, perimeter 8 inches.

2. In an equilateral triangle, side 2 inches, inscribe three equal semicircles, each to touch one side of the triangle, and their diameters to be adjacent.

3. From a circle, diameter 2 inches, cut off a segment to contain an angle of 30°.

QUESTIONS SET AT THE INTERMEDIATE EXAMINATION.

Animal Physiology.

Time allowed—2 hours.

1. Mention the main differences between the *Vertebrata* and the *Invertebrata.*

2. What is the use of *saliva?* Where is it formed?

3. Describe clearly the act of breathing.

4. What organs are contained in the *thorax?* State briefly the function of each.

5. Explain the terms—*muscle, artery, vein, digestion.*

6. Show how bones act as levers.

7. What is the use of valves in the heart? Name those on the left side of the heart.

8. What are tendons? Describe their structure.

9. What gives rise to perspiration? What is its use?

10. What is meant by a nerve centre? Give examples.

Mechanics.

Time allowed—2 hours.

1. What is inertia? Explain why a ball rolled along the ground comes to rest.

2. Explain how the parallelogram of forces may be proved experimentally.

3. Two forces, 20 and 15, act upon a point at an angle of 60°; what is the magnitude of their resultant?

4. State exactly what is meant when the velocity of a body is said to be *uniformly accelerated?* The acceleration of a body's velocity is denoted by 5, the units being feet and seconds; what is indicated by this number 5?

5. What is a pulley? What combinations of pulleys are known respectively as the first, second, and third system of pulleys?

6. On an inclined plane which rises 5 in 13, what power acting parallel to the plane will support a weight of 91 lbs.

7. What is a false balance? The arms of a false balance are 1 foot and 1·03 ft. in length; what will be the apparent weight of 10 lbs. of goods, weighed with this balance, when suspended from the longer arm?

8. What is *Gravity?* Three heavy particles, whose weights are 4, 6, and 8 respectively, are placed at intervals of 9 inches each along a weightless rod; find the distance of the centre of gravity from the middle of the rod.

9. A cubic foot of wood weighs 40 lbs.; to what depth will it be immersed when floating in water?

10. The diameter of the large piston in a hydrostatic press is 20 inches, of the small ¼ inch, the lever is 2 feet long, and is attached to the small piston rod at a point 2 inches from the fulcrum, what is the mechanical advantage of the press?

Chemistry.

Time allowed—2 hours.

1. What is the difference between air which passes into the lungs and that which passes out? How can you prove this difference by experiment?

2. What is the difference between sea water and pure water? How would you prove the difference? How can you obtain pure water from sea water?

3. Define *analysis* and *synthesis*. Give one example of each.

4. Describe the experiment in which an electric current is passed through water. What does this experiment show?

5. Give the distinction between acids, alkalies, and salts.

6. Describe the chief physical and chemical properties of hydrogen.

7. What compounds does nitrogen form with oxygen? Describe the properties of nitrous oxide.

8. Give the chief characteristics of metals and non-metals respectively. Give examples of each class which are exceptional.

9. Describe carbon dioxide and its chief properties.

10. What is the law of chemical combinations in multiple proportions?

Algebra.

Time allowed—2 hours.

1. Two men start together to walk, one at the rate of a miles per hour, the other, more slowly, at the rate of b miles per hour; they both walk for x hours, and the first man for y hours more. Express algebraically, the distance they will be apart at the end of this time if they walk in the same direction.

2. If $a = 4$, $b = 2$, $c = 0$, $x = 5$, $y = 3$, and $z = 1$, find the value of $\frac{3ab + 4bc}{az} - \frac{2xy - 3yz}{xz} + \frac{a^2 - ab + b^2}{yz}$.

3. Multiply $3a^2 - 4ab + 2b^2$ by $2a^2 - 4ab - 3b^2$.

4. Divide $a^5 - b^5$ by $a^3 - 2a^2b + 2ab^2 - b^3$.

5. Find the square root of

$$x^6 - 4x^5 + 6x^4 - 8x^3 + 9x^2 - 4x + 4.$$

6. Simplify $x - [2y + \{3z - 3x - (x + y)\}] + 2x - (y + 3z)$.

7. Solve $\frac{x-2}{3} - \frac{2x-7}{14} = \frac{x}{2} + 2$.

8. Find a number such that, if 36 be taken from its double, the remainder will be ⅔ of the original number.

9. Solve $\frac{x}{5} - \frac{y}{10} = 1$; $\frac{x}{8} + \frac{y}{3} = 4$.

10. A man bought 5 sheep and 8 calves for £30; he sold four of the sheep, at a gain of 10s. each, and six of the calves, at a gain of £1 each, for £31; what did he pay for each?

11. Resolve into three factors $a^2x - b^2x + a^2y - b^2y$.

12. Solve $\frac{2(x-b)}{x+} = \frac{2x-c}{x+c}$.

13. Solve $\frac{2x^2 + x}{x - 3} = 6x - 13$.

Euclid.

Time allowed—2 hours.

1. Define the following:—*Superficies*, *right angle*, *rhomboid*, *gnomon*, and *parallel right lines*.

2. If two triangles have two sides of the one equal to two sides of the other, each to each, and have likewise their bases equal, the angle which is contained by the two sides of the one shall be equal to the angle which is contained by the two sides, equal to them, of the other.

3. Describe a square that shall be equal to a given rectilineal figure.

4. If the square described on one of the sides of a triangle be equal to the squares described on the other two sides of it, the angle contained by these two sides is a right angle.

5. Divide a given straight line into two parts, so that the rectangle contained by the whole and one of the parts may be equal to the square on the other part.

6. Describe a parallelogram that shall be equal to a given triangle, and have one of its angles equal to a given rectilineal angle.

7. If a straight line be divided into two equal parts and also into two unequal parts, the rectangle contained by the unequal parts, together with the square on the line between the points of section, is equal to the square on half the line.

8. On a given straight line describe a square, of which it shall be the diagonal.

Domestic Economy.

Time allowed—2 hours.

1. How would you classify carbonaceous foods?

2. Compare the advantages and disadvantages of obtaining a supply of drinking water for a family—(*a*) from a pump in the backyard, and (*b*) through taps and pipes from a reservoir at a distance.

3. Point out the necessity for a *mixed* diet. Give an example of a dietary suitable to an adult.

4. Mention what internal parts of an animal are useful as food.

5. What are the disadvantages of roasting as a mode of cooking meat? How much time is usually allowed for each pound in roasting?

6. Give recipes for making—(*a*) pea soup, and (*b*) a plain bread pudding.

7. Describe how you would lay a fire ready for lighting.

8. Give full directions for sweeping a carpeted floor, and for disinfecting a room.

9. What precautions would you take when washing—(*a*) flannels, and (*b*) coloured cottons?

10. State briefly the advantages of *thrift*. Point out the ways in which a thrifty woman can safely invest small savings.

Botany.

Time allowed—2 hours.

1. Explain the structure of a cell, and the changes it undergoes in the growth of a plant.

2. What are the principal substances which form the food of plants? Explain how the food is absorbed by the roots.

3. Explain fully the various respects in which a petal differs from a leaf.

4. Mention some of the chief forms of stipules.

5. Define a compound leaf, and describe different kinds of compound leaves.

6. What do you understand by a 'perfect' and an 'imperfect' flower? Describe the arrangement of parts or organs in a perfect flower.

7. Describe the fruit in the strawberry and poppy.

8. Describe the parts met with in the seed of the bean.

9. What is the difference between an annual and a perennial plant.

10. Give a description of the leaf, flower, and fruit of the buttercup.

French.

Time allowed—2 hours.

I. Translate into English:—

1. Avez-vous beaucoup à faire aujourd'hui.

2. Voilà un oiseau! Le vois-tu?

3. Parlez-leur poliment, et ne vous effrayez pas s'ils vous grondent.

4. Il serait chez lui, s'il pleuvait.

5. Ces arbres-là sont plus hauts que ceux-ci.

6. Charles n'est-il pas fâché que nous ne l'ayons pas attendu ?

7. Il faut ici, mon cher ami, ne rien cacher à votre maître.

8. Dans l'école il y a beaucoup d'enfants, mais ils ne sont pas tous dans la même chambre.

II. Grammatical Questions.

1. Give the plurals of :—*cheval, bijou, bal, clou, ciel, grand'père, verre-à-vin.*

2. Give the feminines of :—*son, ce, fidèle, vert, beau, attentif, flatteur.*

3. Write in French :—18, 99, 13th, 26th, *the seventh of January, one-fifth, Henry the Seventh.*

4. Give the third person singular of the indicative future, and of the subjunctive imperfect of :—*avoir, être, parler, finir, aller, devoir, dire.*

5. Give some rules for the position of the adjective, and four examples (*sentences*) of adjectives that have a different meaning according as they are placed before or after the substantive.

III. Translation into French.

1. My uncle has a small house.

2. Has she given him a watch ?

3. If you have lost your pencils look for them.

4. Are you hungry ? No, but I am very thirsty.

5. Edward, do you hear me ? Go to bed ; you are sleepy.

6. How old is your father ? He is sixty-nine.

7. It was necessary that I should bring him more books.

8. Where does your aunt live now ? She has been living in London for the last two years and a half.

ELEMENTARY SCIENCE.

Time allowed—2 hours.

1. Distinguish between the three states in which matter exists.

2. What is *friction ?* Point out some of the effects of friction.

3. At what temperature does water freeze, and at what temperature does it boil ? How would these temperatures be changed by ascending a high mountain ?

4. Describe the construction and uses of a barometer ?

5. What is meant by vibration ? Give a proof that sound requires time to travel.

6. Define evaporation. Why is a liquid that evaporates rapidly intensely cold ?

7. Make careful drawings showing how an image is formed, (*a*) in an ordinary looking-glass, (*b*) in a convex mirror.

8. Roughly sketch an electrical machine, and describe its mode of action.

9. Why does ice float on water ? Why do pipes often burst when the water within them freezes ? State the property of water which is the cause of these two effects.

10. Sketch the common forge-bellows, and explain its action.

DRAWING.—GIRLS.

Time allowed—2 hours.

Freehand.

Candidates are required to copy in pencil carefully the printed example, increasing the height about two inches, and the width in proportion. No ruling or measuring of any kind is allowed.

[The example was a balanced or symmetrical design about equal in difficulty to those usually set for Second Grade or Seventh Standard Examinations under the Science and Art Department. It measured about 5½ inches by 4 inches.]

Geometrical.

1. Construct a triangle, sides 3, 4, and 5 inches respectively.

2. Find a fourth proportional greater to two lines, A 2 inches, B 3 inches.

3. Within a square, side 2 inches, inscribe an oblong, one side of which is ⅔ inch.

4. In a regular hexagon, side 1½ inches, inscribe a circle.

Answers to Questions in Arithmetic.

1. 93,007 + $\frac{18}{43}$.
2. 45 miles per hour.
3. $21\frac{13}{17}$ times.
4. £2 3s. 11½d., and £3 5s. 11½d.
5. H.C.F. = 3 × 5 × 11 = 165.
6. $28\frac{19}{40}$ kilom., or 28·475 kilom.
7. 0.
8. 1·4514.
9. £3.
10. 60 children ; there is a surplus of 90 cubic feet.
11. £63 6s. 5⅔d.
12. $\frac{625 \times 8 \times 4\frac{1}{2}}{1875 \times 4 \times 3}$ will cancel out to ½.
13. £66 13s. 4d.
14. £1 6s. 3d.
15. $22\frac{23}{60}$%.
16. 31½ miles per hour.

Answers to Questions in Mechanics.

3. $5\sqrt{37} = 30{\cdot}4138$.
6. 35 lbs.
7. 10·3 lbs.
8. 2 inches from centre towards the weight 8.
9. 7·68 inches.
10. As 76,800 : 1.

Answers to Questions in Algebra.

1. $(ax - bx + ay)$ miles.
2. $5\frac{4}{5}$.
3. $6a^4 - 20a^3b + 11a^2b^2 + 4ab^3 - 6b^4$.
4. $a^3 + 2a^2b + 2ab^2 + b^3$.
5. $x^3 - 2x^2 + x - 2$.
6. $7x - 2y - 6z$.
7. $x = -7$.
8. 30.
9. $x = 9\frac{5}{19}$, $y = 8\frac{1}{19}$.
10. Sheep, £2 ; calf, £2 10s.
11. $(a + b)(a - b)(x + y)$.
12. $x = \frac{bc}{3c - 4b}$.
13. $x = 6\frac{1}{2}$ or $1\frac{1}{2}$.

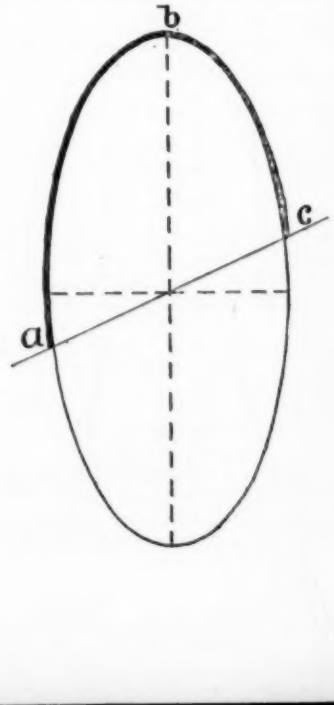
TEACHERS' DRAWING LESSONS.

MODEL.

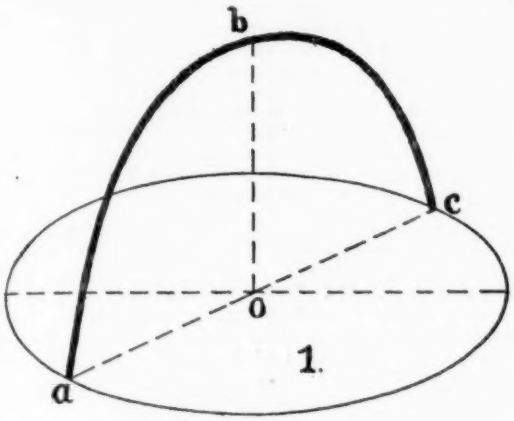
STANDARD VI.

BY E. BUFFERY RIDGE,
Art Master under the London School Board.

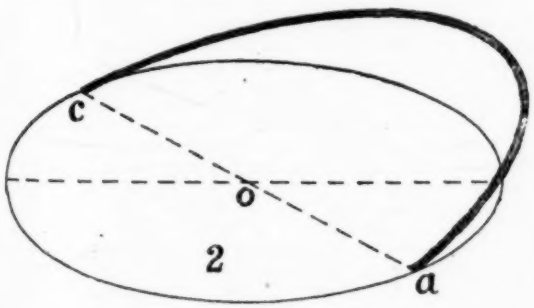
Handles.—Draw an ellipse, and cut it through the centre by a line which is not at right angles to the



major axis. The handles of common objects will very frequently present a curve similar to *abc*. The handle of a zinc pail is an instance.



In fig. 1 the top of the pail is shown as an ellipse, *a* is the near end of the handle. Draw a line from *a* through the centre *o* to get *c*, the far end of the handle. Then measure the height *ob* in proportion to the rest of the figure, and draw the curve, but do not regard *b* as anything more than an *approximate* guide to the height, and the line *ob* as a help towards getting the handle upright. The highest point of the curve will probably be a little further back than *b*. Refer to drawings of cylinder in horizontal positions. The curve should be drawn as in previous lessons on



curves. Fig. 2 shows the same handle in a slanting position. Always obtain *c* by a line from *a* through *o*.

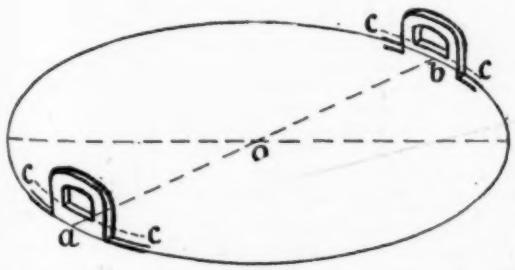


Fig. 3 shows the *Handles of a wooden Washing-tub.*—The centre *o* is again used to place one handle opposite to the other. The lines *cc*, *cc*, follow the curve of the ellipse.

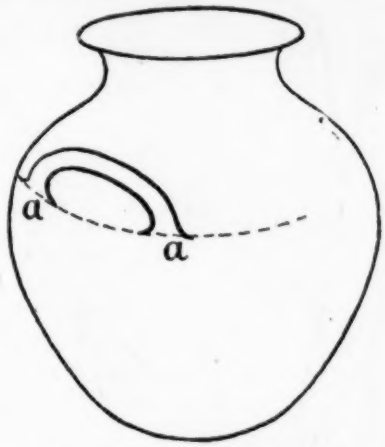


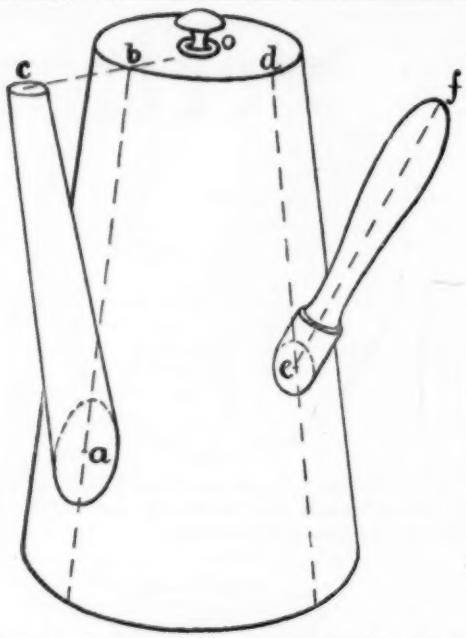
Fig. 4, *Handle of a Vase.*—The points of attachment *aa* are on a line following the curve of the object in a horizontal direction.

Fig. 5, *Handle of a Jug.*—Here the points of attachment are in a curve which would be marked on the surface by a vertical section.

The Spout, opposite to the Handle.—Draw *a* through *o*, then *ab* will give the direction of the curve forming the lip or spout of the jug.

Tubular Spout, Coffee-pot.—*a* is the centre of the oval attachment. A line up the surface to *b* gives the point through which a line from *o* must be drawn to give *c* the top of the spout, on a level with the top of the pot.

The small ellipse at *c* should be drawn with its axis horizontal, not along the line *cb*, and the straight sides of the spout tangent to the ellipses at *c* and *a*. From *b* to *d* is a quarter of the way round, the handles of coffee-pots being usually set at right angles to the spouts. At *e* another oval is drawn, giving the



attachment of the handle. Draw the handle with centre line *cf*.

CONVERSATIONAL LESSONS IN CHEMISTRY.

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LESSON XX.—ZINC.

THE substance about which we are going to speak to-day is so well known that you will all be able to recognise it as soon as you see it. Here it is. What is its name? It is zinc, sir. Of course: now tell me for what purpose we have used it. For the preparation of H, sir. Exactly. How, Minnie? By simply placing Zn in HCl or H_2SO_4. Very good, and what bodies will be produced when the H is evolved? You shall answer, Trixie. The chloride and the sulphate of zinc, sir. Yes: now how could we get these bodies supposing we wished to examine them? By evaporating their solutions which are found in the flask after the H has been evolved. Well, that would be right in the case of the sulphate, but not quite so with the chloride. However, we need not concern ourselves with the difference now. Let us get back to the metal. What is its colour? Greyish white. Yes. Now what is this specimen? Is it not zinc foil, sir? Yes. And this powder is zinc also. What does that teach you? That zinc is both malleable and brittle. But is that not a somewhat contradictory statement? How can you explain it, Bob? Is it because the metal behaves differently at different temperatures, sir? Ah, that is a lucky guess, Master Bob, but I fear it is nothing but a guess. It is almost so, sir, but we have seen that heat can change brittle sulphur into plastic sulphur, and why should it not do the same with zinc. Well worked out, Bob, and I withdraw my accusation and proceed to explain. This zinc that I am hammering has been heated until of about the temperature of boiling water. See, it is not brittle, but distinctly malleable. Now turn your eyes in the direction of this mortar with the Bunsen burner under it. It is, as the thermometer placed within it shows, at about twice the temperature of boiling water, viz., 200°C., at which degree of heat the malleability completely vanishes, and we can easily get the powder you see before you. For what purposes is zinc used? Let Lilla answer. When we had our lesson on copper, sir, we learnt that copper and zinc together make brass. Very true, and just as important as true if you remember the many uses to which brass is put. We will take you next, Lionel. Is it not true, sir, that galvanised iron is simply iron covered with zinc? Yes, your information is correct on that point. Can you go a step further and say why we so cover the iron? To protect it, of course, sir. Protect it from what? Well, as you hesitate, try and tell me what is the great destroyer of iron. Rust, sir. How is rust formed? It is formed whenever iron is placed in moist air. What is iron rust? It is a compound of iron and oxygen. Well, yes, that is near enough for our purpose, and so the zinc will be used to protect the iron from the oxygen of the air. Now carefully think what that should mean. It should mean, sir, that zinc does not easily oxidise—does it not? Well, here is a specimen that has been exposed to the air for a short time only. Yet please observe that it is coated with a layer of oxide, for this white substance is the oxide of zinc. Now you are puzzled, and I must take pity on you. There is another specimen of zinc that has been exposed to the atmosphere for several months. Compare the two. In which is the layer of oxide the thicker? Go on, Bob. It seems to me, sir, that there is little to choose between them. That is so, and now again try and find why. Listen to Annie. Is it because the zinc under the oxide cannot be further acted upon by the air, sir? You have just hit upon the right explanation, and you can all see now that zinc is a good protector of iron, although it oxidises even more easily than that metal. I need scarcely tell you that there is no galvanising at all about the business, seeing that the iron is simply immersed in the molten zinc. Take a piece of the foil, John, and hold it in the Bunsen with your crucible tongs. Observe the blue flame of burning zinc, and now let us look at your tongs. What is that yellow substance? It is zinc oxide, is it not, sir? Yes, but we settled just now that the oxide was white. Well, what have you to say, John? Look, sir, it is white now. Yes, and it is characteristic of zinc oxide that it is yellow when hot and white when cold. This same white body is of great use to the painter since it can be used in place of white lead, compared with which it has the great advantage of not turning black when acted upon by sulphur, seeing that zinc sulphide is white. Here is a specimen of the sulphide. Well, Bob? That is not white, sir. No, it is brown, as you can all see. Its colour is probably due to impurities contained in it. But see, I pour a solution of sulphuretted hydrogen into this solution of zinc sulphate, or white vitriol as it is called, and the white precipitate of zinc sulphide is readily apparent. This brown substance, yellow specimens of which are not infrequently found, is called *blende*, and it is one of the most important ores of zinc. The most important ore is zinc carbonate, of which I now show you a specimen. It is called *calamine*. One more point of importance and we will conclude our lesson. If we heat the carbonate or burn the sulphide, the same body is in each case formed. Can you tell me what this should be? It is the oxide, sir, for in the case of the carbonate, CO_2 would be driven off as in making lime from limestone, and in the case of blende we should get SO_2 and ZnO. Very true, and that leads up to the last question which I want you to answer. How can you reduce the oxide to metal since zinc is volatile and would go off as a gas at the temperature of the blast furnace? Listen to Tom. Would it not be possible, sir, to condense the gas even if the blast furnace should volatilise the zinc as soon as it is set free? That is a very thoughtful question which at once leads to a solution of our difficulty. Yes, zinc, like iron, is extracted from its ores (calamine or blende) by the reducing action of carbon at very high temperature, the extraction, however, takes place in furnaces specially constructed to condense the zinc fumes and convert the gas into the solid metal. We have now learnt—

(1) That zinc is found in nature as sulphide—ZnS—(*blende*), and as carbonate—$ZnCO_3$—(*calamine*), and that it is extracted from these ores by means of carbon in specially constructed furnaces.

(2) That the metal is volatile and readily oxidises.

(3) That it readily dissolves in acids, in which way we have formed the chloride and sulphate.

(4) That it is used for making copper and as a pigment.

(5) That at the boiling point of water it is malleable, whereas at twice this degree of heat it is brittle.

Keep these facts well in mind until we are able to deal with this interesting metal more exhaustively.

Our Science Section.

CHEMISTRY NOTES.

BY W. TATE, A.R.C.S., F.C.S.

GENERAL NOTES.—*Argon: a New Constituent of the Atmosphere.*

Under this title a memorable paper was delivered to the Royal Society on January 31st by Lord Rayleigh and Professor W. Ramsay. The former had previously shown that 'Atmospheric Nitrogen' differed in density from 'Chemical Nitrogen,' that is nitrogen liberated from some one of its compounds. The weights of gas contained in a certain globe under the same conditions of temperature and pressure were found to be as follows:—

Atmospheric Nitrogen, prepared—

(1) By hot copper ...	2·3103	Mean 2·31016.
(2) By hot iron ...	2·3100	
(3) By ferrous hydrate ...	2·3102	

Chemical Nitrogen, prepared—

(1) From nitric oxide ...	2·3001	Mean 2·29900.
(2) From nitrous oxide ...	2·2990	
(3) From ammonium nitrite purified at a red heat ...	2·2987	
(4) From ammonium nitrite purified in the cold ...	2·2987	
(5) From urea by sodium hypobromite	2·2985	

Since the discovery of the new constituent of the atmosphere, 'chemical nitrogen' has been formed from *magnesium nitride*, produced by the combination of '*atmospheric nitrogen*' and magnesium at a bright red heat. Water reacts with this nitrogen compound as follows:—

$$N_2Mg_3 + 3H_2O = 2NH_3 + 3MgO.$$

The ammonia is then converted into nitrogen by means of calcium hypochlorite in accordance with the equation—

$$3Ca(OCl)_2 + 4NH_3 = 3CaCl_2 + 6H_2O + 2N_2.$$

The above-mentioned globe contained 2·29918 of this 'chemical nitrogen,' *which had previously existed as 'atmospheric nitrogen'*; its weight corresponds with that of nitrogen prepared from other compounds.

The weight per litre, under standard conditions, of chemical nitrogen is 1·2505 grams, that of atmospheric nitrogen 1·2572 grams.

Hence, if $O_2 = 16$ we have $N_2 = 13·9954$ from chemically prepared nitrogen. The ratio is nearly that of 16 : 14.

Another sample of nitrogen from magnesium nitride, weighed in a different apparatus and prepared somewhat differently, gave 1·2521 grams per litre. Ammonium chloride prepared from different samples of nitride was found to contain the same percentage of chlorine as that from other sources, and hence could not contain any other basic constituent with a different equivalent from that of ammonia.

The difference in density of atmospheric and chemical nitrogen is due to the presence of a denser gaseous constituent impurity in the former, and this impurity is not withdrawn by red-hot magnesium.

The alternative supposition, *that the difference in density may be due to a lighter impurity contaminating the chemical nitrogen*, was disproved by proving the absence of hydrogen, the only lighter foreign gas conceivably present, and demonstrating that dissociated N atoms could not be in existence compatibly with the known properties of the chemical nitrogen.

In order to isolate the denser constituent of 'atmospheric nitrogen' it is necessary to remove the nitrogen by causing it to combine with some other element. Nitrogen combines directly with boron, silicon, titanium, lithium, strontium, barium, magnesium, aluminium, and mercury. Under the influence of an electric discharge, it combines with hydrogen in presence of an acid, and with oxygen in presence of an alkali.

Cavendish found it impossible to completely remove atmospheric nitrogen from a tube by sparking with oxygen over potash. He always found an unabsorbable residue, 'not more than $\frac{1}{120}$th part of the whole' (air).

Cavendish's residue was probably the newly discovered 'Argon' which has been prepared in small quantities by removing nitrogen from 'atmospheric nitrogen' by his process of sparking.

The most convenient method of preparing Argon on the large scale depends on the absorption of nitrogen by metallic magnesium.

Air is freed from oxygen by means of red-hot copper. The residue is passed again over red-hot copper contained in a combustion-tube heated in a furnace in order to eliminate the last traces of oxygen. The issuing gas is dried by passing over soda-lime and phosphorus pentoxide, and its rate of flow indicated by a small sulphuric-acid bulb. It then passes through a second tube similarly heated and packed tightly with magnesium turnings. From this tube it passes through a second index-tube and enters a small gas-holder capable of holding three or four litres. A single tube of magnesium will absorb 7 or 8 litres of nitrogen. The heat must be carefully regulated and maintained just below the fusing-point of the glass; this requires a slow current of gas, as heat is evolved during the formation of the nitride N_2Mg_3.

The residue from 100 or 150 litres of atmospheric nitrogen, which may be 4 or 5 litres, is transferred to a small gas-holder. Hence it is circulated, by means of a special form of automatic Sprengel pump, through a tube half filled with copper and half with copper oxide; it then passes through a tube containing soda-lime at one end and phosphorus pentoxide at the other end; and so on to a 300 c.c. reservoir, from which, by raising a mercury reservoir, it may be forced into another small gas-holder. It then

again passes through a tube containing magnesium turnings heated to bright redness. The gas is thus freed from any possible contamination with oxygen, hydrogen, or hydro-carbons, and nitrogen is gradually absorbed. As the amount of gas in the tubes and reservoir diminishes in volume, it draws supplies from the gas-holder, and, finally, the circulating system is full of argon in a pure state. The complete removal of nitrogen from argon is very slow towards the end, but circulation for a couple of days usually effects it.

The oxygen method of separating nitrogen by sparking over potash has been much improved, but is still a very tedious and difficult process for the isolation of argon. By this method 65 c.c. of argon were obtained from 7,925 c.c. of air after 9 days' work. The atmosphere therefore contains 0·82 per cent. of argon by volume. Cavendish came wonderfully near this figure when he found an unoxidizable residue of about $\frac{1}{120}$th = 0·83 per cent. of the volume of the air taken.

The density of argon may be calculated roughly from the densities of atmospheric nitrogen and chemical nitrogen. Thus, the proportional volume of argon in atmospheric nitrogen—

$$a = \frac{65}{0{\cdot}79 \times 7925},$$

D and D^1 are masses of chemical nitrogen and atmospheric nitrogen respectively occupying the experimental globe; then, d being the corresponding mass of argon, we have—

$$ad + (1 - a)\,D = D^1$$

$$\text{hence } d = D + \frac{(D^1 - D)}{a}$$

$$\text{or } d = 2{\cdot}2990 + \frac{(2{\cdot}3102 - 2{\cdot}2990) \times 0{\cdot}79 \times 7925}{65}$$

$$\therefore d = 3{\cdot}378.$$

If the density of chemical nitrogen be taken as 14, the density of argon must be—

$$\frac{14 \times 3{\cdot}378}{2{\cdot}299} = \underline{20{\cdot}6}.$$

The density of argon prepared by magnesium gave results varying between 19·09 and 20·38. The most reliable results gave 19·90 as the true relative density of argon. The molecular weight of argon must therefore be approximately 40, twice its density; for by Avogadro's hypothesis the molecular weights of gases are proportional to their densities, and hydrogen, the unit of density, is assumed to have the molecular weight 2. This, of course, assumes that argon is a single element and not a mixture. The evidence points strongly to the truth of this assumption: argon has a definite melting-point, a definite boiling-point, and a definite critical temperature and pressure; on compressing the gas in presence of its liquid, pressure remains sensibly constant until all the gas has condensed to liquid. These are the criteria of a pure substance. On the other hand, it may be urged that argon gives two characteristic spectra when the electric discharge is passed through the suitably rarefied gas; this, however, is hardly an argument against its chemical simplicity when it is remembered that more than one spectrum may be obtained by suitably torturing undoubted chemical individuals such as oxygen.

Argon appears to be the most inert of chemical substances; all attempts to cause its combination with other substances have hitherto failed. Argon does not combine with oxygen in presence of alkali under the influence of the electric discharge, nor with hydrogen in presence of acid or alkali also when sparked; nor with chlorine, dry or moist, when sparked; nor with phosphorus or sulphur at a bright red-heat. Tellurium, sodium, and potassium may be distilled unchanged in a current of the gas. It is unabsorbed by passing over red-hot caustic soda, soda-lime, potassium nitrate, or sodium peroxide. Persulphides of sodium and calcium are also without action at a red heat. Platinum-black and platinum-sponge do not absorb it. Wet oxidizing and chlorinating agents, such as nitro-hydrochloric acid, bromine-water, bromine and alkali, and hydrochloric acid and potassium permanganate, are entirely without action. Mixtures of sodium and silica and of sodium and boracic anhydride are also without action; hence it appears to resist attack by nascent silicon and by nascent boron.

No compounds of argon being at present known, it has not been possible to find its equivalent, and hence its atomic weight, in the usual way.

It has been possible, however, to more or less definitely ascertain its molecular complexity by a somewhat circuitous physical process. Clausius has shown that if K be the energy of translatory motion of the molecules of a gas, and H their whole energy of motion, then

$$\frac{K}{H} = \frac{3\,(Cp - Cv)}{2\,Cv}$$

where Cp and Cv denote the specific heats of the gas at constant pressure and constant volume respectively. But the ratio of these specific heats, that is the value of the fraction $\frac{Cp}{Cv}$, may be deduced by determining the velocity of sound in the gas at known temperature and pressure.

Then—

$$V = \sqrt{\left\{\frac{e}{d}(1 + at)\frac{Cp}{Cv}\right\}}$$

where e = the elasticity, d = the density, and a = the coefficient of expansion of the gas, and t is the temperature of experiment.

This velocity of sound has been determined in argon with every precaution by the method of Kundt and Warburg.

The values obtained thus for $\frac{Cp}{Cv}$ with two different samples of argon were 1·61 and 1·65, practically and within experimental errors $1\frac{2}{3}$.

Hence—

$$\frac{K}{H} = \frac{3\,(Cp - Cv)}{2\,Cv}$$

$$= \tfrac{3}{2}\left\{\frac{\frac{Cp}{Cv} - 1}{1}\right\}$$

$$= \tfrac{3}{2}\{1\tfrac{2}{3} - 1\}$$

$$= \tfrac{3}{2} \times \tfrac{2}{3} = 1.$$

That is K = H, or the energy of translatory motion is the whole energy of motion in the molecules of argon.

This can only be the case on one of the following assumptions: (1) That the gas is monatomic, and so cannot have movement within the molecule; or, (2) that the molecule contains more than one atom, and these atoms are so rigidly bound together that they have no movement with relation to each other. In either case any energy of rotation of the molecule must be so small as to be negligable.

In the first case, as the molecule consists of a single atom, it follows that the molecular weight is also the atomic weight. This is the assumption held to be most probable in the case of argon. *The atomic weight of argon is therefore probably about* 40.

On the second assumption, we should have no means of determining the atomic weight of argon from known facts. Although the exceptional inertness of argon would be explained by the intensity of the attractive forces exerted between the atoms in its molecule, we should be quite without parallel or precedent in supposing such a constitution, whereas the monatomic molecule is found also in the cases of gaseous mercury, cadmium, and zinc at least. Further, the monatomic molecule can explain the inertness of argon by an extension of the comparison with gaseous mercury, for argon may be in the same state as mercury vapour at a very high temperature when it is not known to form stable compounds.

The discoverers of argon discuss its probable position in Mendelejeff's 'Periodic System of the Elements.' This is so much a matter of mere speculation that it would be unprofitable for their conjectures to be given here.

Certain other of the physical properties of argon have been determined; for instance, its solubility in water is greater than that of nitrogen and about equal to that of oxygen. 100 volumes of water dissolve 3·94 volumes of argon, prepared by sparking, at 12°, and 4·05 volumes of argon, prepared by magnesium, at 13·9°.

The critical constants of argon were the basis of another communication to the Royal Society by Dr. K. Olszewski (Cracow University). The following table compares these constants for argon and some other gases:—

——	Argon.	Oxygen.	Nitrogen.	Nitric Oxide.
Critical temperature. Below..	— 121·0°	— 118·8°	— 146°	— 93·5°
Critical pressure. Atmos.	50·6	50·8	35·0	71·2
Boiling point ...	— 187·0°	— 182·7°	— 194·4°	— 153·6°
Freezing point ...	— 189·6°	?	— 214·0°	— 167·0°
Density of gas ...	19·9	16·0	14·0	15·0
Density of liquid at boiling point	About 1·5	1·124	0·885	?
Colour of liquid...	Colourless	Bluish	Colourless	Colourless

Practical Notes.—Commercial sulphuric acid is generally contaminated by impurities introduced during the process of manufacture and concentration. The concentrated acid supplied to laboratories is usually nearly free from these impurities, containing only a little lead. Lead may be tested for by the addition of one part of the sulphuric acid to about six parts of water; if present, a white precipitate of lead-sulphate will be formed. This precipitate is probably produced by the decomposition of the acid salt—$PbSO_4$. H_2SO_4; its complete separation is ensured by the addition of an equal bulk of alcohol to the diluted acid. The lead finds its way into the acid from the chambers and during the concentration in leaden pans. The most common other impurities are: arsenic, iron, nitric acid, and oxides of nitrogen. Arsenic is introduced from the pyrites used for the production of sulphur dioxide; it should be tested for by diluting largely and passing hydrogen sulphide after filtering off any $PbSO_4$. Traces should be examined for by Marsh's test. Iron, derived from the pyrites, may be detected by diluting largely and adding potassium sulphocyanate; a blood-red coloration indicates iron. Nitroxygen compounds may be detected by pouring about two cubic centimeters of the concentrated acid carefully down the side of a slanting test-tube containing a solution of ferrous sulphate, when a dark-brown or black ring is formed at the surface of contact of acid and solution.

Nitric acid is most liable to contamination by sulphuric and hydrochloric acids and nitrogen oxides. The acid is colourless when the higher oxides of nitrogen are absent. Dilute the acid with five times its bulk of water and add (1) silver nitrate and (2) barium chloride to separate portions; (1) HCl and (2) H_2SO_4 are indicated by characteristic precipitates.

Hydrochloric acid may contain chlorine, H_2SO_4, iron, arsenic, and sodium. Sulphuric acid is detected by addition of $BaCl_2$ to the *diluted* solution. Iron is present as ferric chloride in considerable quantity in much of the commercial acid; it may be recognized by the orange or reddish-brown colour of the concentrated acid and by precipitation as prussian blue by addition of potassium ferrocyanide to the diluted sample. Traces may be detected in the pure acid by sulphocyanate added to a cold and very dilute solution of the acid. Arsenic is derived from the sulphuric acid used in the manufacture; it may be detected by passing hydrogen sulphide through the concentrated acid. To detect chlorine, if iron be present it is useless to test directly with potassium iodide and starch-paste, and the bleaching action is not delicate enough to serve as a test; slowly distil about half from a portion of the acid contained in an inclined flask, dilute the distillate, and test with potassium iodide and starch; a blue coloration indicates free chlorine. Evaporate about 50 c.c. of the acid to dryness, and examine any residue for sodium by the flame test.

Ammonia solution is generally very free from impurity. It may contain a little carbonate; dilute and add lime-water, a white precipitate of $CaCO_3$ may settle out after standing for a few minutes. Commercial ammonium chloride usually contains iron. Test the solution with potassium ferrocyanide or by addition of a few drops AmOH and standing.

References.—Journal of the Chemical Society, February 1895. Read 'A note on the Interaction of Bismuth Haloïd Compounds and Hydrogen Sulphide,' by MM. Pattison Muir and Edwin M. Eagles (pages 90–93); 'Hydrate of Carbonic Anhydride: Composition of Gaseous Hydrates,' by P. Villard (abstracts, page 44); 'Double Salts of Higher Chlorides of Manganese and Copper,' by G. Neumann (abstracts, page 46); 'Sodium Thiosulphate for Standardizing Iodine Solutions,' by G. Meineke (abstracts, page 63).

Notes on Questions.—*Adv.* (12). See Newth, pp. 390–393. *Adv.* (13). See Newth, p. 81. Atmolysis has been used to demonstrate that air is a mixture by causing atmospheric air to diffuse through porous septa into carbon dioxide; after absorption of the carbon dioxide, the diffused air was found to contain a less proportion of oxygen than atmospheric air, and hence was proved to be a gaseous mixture. Ammonium chloride has a vapour density only half as great as required by the formula NH_4Cl. It has been shown by atmolysis that the vapour contains *not* NH_4Cl, but a mixture of NH_3 and HCl, and hence that the vapour density determined is really the mean vapour density of a mixture of equivalent proportions of NH_3 and HCl. A hard glass tube, about 18 inches long and ¾ inch in diameter, is fitted with two-hole caoutchouc bungs at each end. The stem of a clay pipe is passed through each bung, and glass delivery and exit tubes are fitted in the remaining holes. A little solid dry NH_4Cl is placed in the centre of the hard glass tube and heated strongly by a bunsen burner, the ends of the tube being closed by the caoutchouc bungs. During the heating, a very slow current of air is passed through the pipe-stem and, by means of a bent glass tube, bubbled through a slightly acid solution of litmus; the litmus becomes blue owing to the excess of NH_3 which has diffused into the pipe-stem from the gaseous mixture in the glass tube. A similar air-current conducts the gases remaining outside the pipe-stem into a solution of slightly alkaline blue litmus, when the excess of HCl remaining is indicated by the reddening of the litmus. *Adv. Prac.* (7). Fuse with KNO_3 for ten minutes on platinum. A sufficient amount of the soluble potassium aluminate is then formed to serve for the detection of alumina. Ferric hydrate remains as insoluble Fe_2O_3. The use of sodium carbonate is thus obviated. On fusing KNO_3 oxygen is evolved and nitrite formed, $2KNO_3 = 2KNO_2 + O_2$. Potassium aluminate is formed by combination of Al_2O_3 with K_2O from the nitrite or nitrate; thus $Al_2(OH)_6 + 6KNO_3 = Al_2(OK)_6 + 3H_2O + 3NO + 3NO_2$. *Adv. Prac.* (8). Use the permanganate method, described in the February issue, to expel the bromine, and test for nitrate in the slightly pink solution in the usual way with $FeSO_4$ and conc. H_2SO_4. If small quantities of HNO_3 only are present, add NaOH to the pink solution till alkaline, and then concentrate to a few drops; pour off remaining solution from the deposited salts and test it by the ring-test. *Hon.* (11). Refer to Thorpe's 'Quantitive Analysis,' p. 100.

Exercises.

Advanced Stage.—(14) Under what conditions can the hypochlorite in bleaching powder be converted into chlorate? How is calcium chlorate converted into potassium chlorate on a large scale? (S. & A. D. 1894). (15) Explain precisely the meaning of the terms: equivalent, molecule, atomic weight, valency, and molecular weight. How can the atomic weight of a metal such as copper be accurately ascertained? (16) What are the data necessary to find the atomic weights of elements such as oxygen and carbon? (17) How can magnesium nitride be prepared? What volume of nitrogen measured dry at 772 mm. and 17° C. can be obtained from 10 grams of this substance?

Advanced Practical.—(9) Give a short account of the method you would employ for the detection of the constituents of a solid mixture insoluble in water or concentrated acids. (10) How would you distinguish (*a*) a phosphate in presence of an arsenate; (*b*) barium chromate in presence of lead chromate; (*c*) potassium platinochloride in presence of ammonium platinochloride?

Honours.—(13) What is isomorphism? Give examples, and state any conclusions you can legitimately draw from the phenomena of isomorphism. (14) 0·9890 gram of phosphoryl bromochloride gave 2·372 grams of mixed silver chloride and bromide. Show that this result agrees with the formula $POBrCl_2$ (1894 S. & A. D.). (15) Give an account of the isolation of 'Argon' from the atmosphere. What is the evidence on which is based the statement that its molecular weight is represented by the same number as its atomic weight? Discuss any other interpretations of the evidence in question.

HONOURS PHYSIOGRAPHY NOTES.

BY A. M. DAVIES, B.SC. (LOND.), F.G.S.,
Late Demonstrator in Geology at the Royal College of Science.

Sulphur in Sea-water and Marine Deposits.

It was incidentally mentioned in the notes on the Black Sea that in that sea the water, at great depths, contained large quantities of dissolved sulphuretted hydrogen (H_2S), and that the Russian explorers regarded this gas as derived from the decomposition of organic remains. More recently, Dr. Murray (of the 'Challenger' Expedition) and Mr. Irvine have investigated the subject of the chemical changes in sea-water in contact with deposits of Blue Mud, and are led to a different conclusion with regard to the Black Sea waters.

'Blue Mud' consists of material of terrigenous origin, which is mostly deposited between 125 and 2,800 fathoms, surrounding nearly all coasts, and filling almost all enclosed seas—the total area covered by it being estimated at 14,500,000 square miles.

The actual depth at which its deposition begins, however, is entirely dependent on the height and length of the waves, so that in sheltered harbours it may be deposited in quite shallow water. On analysing samples of the water in immediate contact with the mud, it was found that the proportion of sulphates is greatly reduced, calcium sulphate being quite absent; while that of carbonates is increased to ten times its normal amount. Ammonium sulphate and manganese carbonate, which are not found in normal sea-water, make their appearance in the bottom-water.

These facts, taken in conjunction with the remarkable constancy of the *mutual proportions* of the various salts in all oceanic water whatever may be their total proportion, show that much chemical change is going on where 'Blue Mud' is being deposited. As a result both of observations and of experiments made in imitation of the natural conditions, Messrs. Murray and Irvine conclude that the series of changes is as follows:—

The carbon and hydrogen of the organic substances in the Blue Mud undergo oxidation at the expense of the sulphates in the sea-water, the nitrogen, at the same time, giving rise to ammonia in the usual way.

The principal sulphates in sea-water are those of calcium, magnesium, and potassium; these are reduced to sulphides, which are in turn decomposed by the CO_2 formed. Thus we have formed carbonates and H_2S. The latter may again be oxidised to sulphuric acid, and again form sulphates from the carbonates—the processes being thus reversed according to the variation of conditions. Some of the H_2S will, however, combine with the iron oxide that is abundant among the deposit, forming iron sulphide, which when finely disseminated through the mud causes the characteristic blue colour.

The formation of the important deposit known as 'Blue Mud' therefore indicates the presence of decomposing organic matter in the deposit, and the absence of sufficient dissolved oxygen in the sea-water to complete the oxidation. The latter condition is not surprising in view of the fact that deposition of this fine material only takes place on sea-bottoms out of the reach of the waves, since it is

by the agitation of waves at the surface of the sea that oxygen is dissolved.

Red muds and clays owe their colour to the abundance of iron in the oxidised condition, and they must be formed either in the presence of an excess of oxygen, or on account of a deficiency in organic matter.

These conclusions can be applied to the stratified deposits of all geological ages. Among the later ones, dark blue clays (like the London Clay, Gault, Kimeridge, Oxford, and Lias Clays) are abundant, and usually of great thickness.

The blue colour is only seen in freshly exposed cuttings, for on exposure to the atmosphere the iron sulphide rapidly oxidises, and the ferric oxide formed gives the clay a rusty-brown colour. Sulphuric acid is also formed by the oxidation, and this attacks any calcium carbonate that is present (generally in the form of fossil shells), producing calcium sulphate, which forms the familiar selenite crystals of the London Clay. Thus the final decomposition of the clay results in the production once more of the most important of the sulphates removed from the original sea-water under which the deposit was laid down.

Among the older rocks the clays are hardened and compressed into shales and slates, and in these the iron sulphide is often aggregated into crystals of iron pyrites.

To return to modern deposits, the experiments of Messrs. Murray and Irvine show that it is only by the action of bacteria that the reduction of sulphates takes place. The case of the Black Sea they regard as peculiar, though they do not accept the view that the sulphuretted hydrogen there is derived directly from the sulphur in decomposing organic matter. They regard it simply as formed in the same way as in the open ocean, but as remaining in the free condition owing to the absence of sufficient iron for it to combine with, and also to the presence of an excess of CO_2, which decomposes any other sulphides that may be formed.

Static and Dynamic Metamorphism.

Prof. Judd, in a paper in the *Geological Magazine*, has called attention to the fact that all pressure-metamorphism of rocks is not necessarily dynamic, *i.e.*, that chemical changes may be set up in rocks by pressure, without the rocks yielding to the stress. Such metamorphism he calls static, insisting that the general term 'dynamo-metamorphism' should be restricted to the cases where the chemical changes have been preceded by the crushing or shearing of the rock which is unable to resist the stresses to which it is subject. He quotes the opinions of physicists, such as Spring and Van der Waals, who have found that under great pressure the molecules of solids can come into as close admixture as those of liquids, and chemical interaction may take place between them. At great depths in the earth's crust the whole substance of rocks, whether crystals or amorphous matter, is permeated by liquids and gases, and under these conditions the phenomena of 'schillerization' are produced (*Hons. Phys.*, pp. 155, 156). These appear to be due to the existence in many minerals of certain 'planes of maximum solubility,' such as can be shown to exist in calcite, by etching a crystal with weak acid. These planes only show themselves in minerals like felspar or augite when the dissolving power of water is increased by the intense pressure: along these planes solution takes place, and the resulting cavities are afterwards filled in with other material. In the case of minerals that do not appear to possess predominating planes of easy solubility, the dependence of the formation of such minute cavities on pressure is very evident. A very good case of this has been described by Prof. Judd: a quartzite pebble had been 'faulted' in a small dislocation in the neighbourhood of one of the great faults of the Highlands. Before it yielded to the stress it must have been in a condition of intense strain. The quartz-grains indiscriminately arranged in the quartzite were found to be permeated by a large number of minute cavities containing liquid, which are arranged in parallel planes that traverse all the grains of quartz alike, regardless of their individual structure, and are parallel to the direction of the fault-plane. These lines of enclosures, so characteristic of all kinds of quartz, are thus, in this case at least, shown to be quite independent of the origin of the quartz, and to have been formed in it, long after its formation, under the action of powerful earth pressures. Similar phenomena have since been described by Prof. Sollas in the Leinster granites. It should be noted that they are due to the influence of pressure on a portion of rock that has resisted its stress.

One of the most complete examples of mineral change induced by pressure is that of a Scandinavian rock described by Prof. Judd. This, as it originally consolidated, must have consisted of enstatite and felspar. Under the action of *static* metamorphism, the enstatite was converted into the 'schillerized' variety, bronzite, while the felspar had developed in it lines of cavities filled with solution of sodium chloride. In this condition the rock is found, but in certain places it has yielded under the strains it has been subjected to, and dynamo-metamorphism has taken place. The bronzite has been converted into hornblende and the felspar into scapolite—an entirely new rock being apparently formed. Finally, on artificial fusion and re-crystallization of this last, an enstatite-felspar rock is produced, thus completing the cycle of change.

The Astronomical Theory of the Ice Age.

The view that the Ice Age was caused by the seasonal conditions of a period of great eccentricity of the earth's orbit was set forth by the late Dr. Croll in a series of writings, and has been recently supported by Sir Robert Ball.

In recent numbers of the *Geological Magazine*, Mr. E. P. Culverwell has subjected this theory to a severe criticism. This author adopts a new and simple method for determining the climatic conditions of any latitude during a period of great eccentricity: he ascertains, by calculation, the parallel of latitude which *now* receives the same amount of sun-heat in winter as any given parallel received in a period of great eccentricity when its winter was in aphelion. The general results of his calculations are that the winter isotherms would, as compared with the existing ones, undergo a southward displacement of 4° at the most, in so far as they were influenced by sun-heat alone. This amount of shifting is less than the amount which, at the present day, any one of the northern isotherms undergoes in its course through purely geographical causes. (See Map, *Elem. Physiog.*, p. 248.) It follows from this, that astronomical causes are less potent in their influence on climate than such terrestrial causes as the distribution of land and water.

Some of the apparently terrestrial causes represent, however, only the indirect action of astronomical ones. Thus Dr. Croll maintained that the climatic conditions when the Northern Hemisphere had its winter in aphelion during a period of great eccentricity would lead to the southward shifting of the median line between the trade-winds, and the changing of the great equatorial currents, whose warm waters would be diverted southwards. Mr. Culverwell's calculations do not make such a change appear very probable. If the Gulf Stream was *not* diverted from its present course under the stated astronomical conditions, its waters must have carried greater warmth to the North temperate zone than they do now, since they would receive much more sun-heat than now in the short but hot perihelion summer (and owing to the slow motion of the Gulf Stream, it is heat received 10° to the south in summer that it gives out in winter). In fact, in spite of the plausibility of Croll's astronomical theory of the Ice Age, it would be, Mr. Culverwell suggests, equally plausible to assert that the period of aphelion winter was one of mild and equable climate, and that it was in perihelion winter that glaciation of the Northern Hemisphere took place: for then the greater heat of winter would be almost entirely received by the Southern Hemisphere, while the colder summer would diminish the heating effect of the Gulf Stream, and thus the snow of winter might escape summer melting. Neither of these two views is likely to stand careful statistical criticism, so we are driven to assume either the efficiency of purely terrestrial causes, such as the distribution of land and sea, to occasion the glaciation of a large part of the earth's surface, or the existence of some yet undiscovered cause. In view of the undoubtedly great effect of land and sea distribution on climate, it would be dangerous to assert that the coöperation of any other cause was really necessary. A suggestion made by Mr. Culverwell may, however, be mentioned: it is that in the earth's passage through space the atmospheric pressure may be altered by diffusion of gases between the atmosphere and the regions through which we pass, or by the addition to the atmosphere of the gaseous portions of meteorites. In view of the importance of the solid matter that is being added to the earth's mass, such an alteration in the atmosphere seems not at all improbable: it must be left to the careful and minute meteorological observations of future centuries to ascertain whether there is a secular variation in atmospheric pressure or not. An increase of $\frac{1}{3}$ of a millimetré per century would mean that 25,000 years ago the atmospheric pressure was one-tenth less than it is now, and consequently that the snow-line was 2,500 feet lower. Thus the Ice Age could be accounted for; but it is hardly necessary to add that this is a purely hypothetical explanation.

SCIENCE NOTES.

The New Element.—The last discovery of science was made the occasion for a new departure by the Royal Society, who convened a special meeting for a discussion of the whole subject on January 31st. The meeting was held in the theatre of the University of London, and was attended by all the leading scientific men of the country. The interest that had invested the subject since the preliminary announcement made at the meeting of the British Association at Oxford last August found full expression in the crowded

audience, which numbered close upon 1,000. The occasion has been aptly spoken of as an historic one; indeed, the discovery marks an epoch in the history of physical and chemical investigation. Led to the conception of the presence of a new body in the atmosphere by a curious abnormality in the density of atmospheric nitrogen, which invariably was found to be greater than the accepted composition of air led physicists to expect, Lord Rayleigh and Professor Ramsay have traced it gradually by two independent methods of research, and have satisfactorily proved that nearly one per cent. of the atmosphere consists of the new body, which has been named *argon*. It is, perhaps, premature to speak of it as a new element, but the general tendency among chemists is to consider it such, as it is capable of liquefaction, has a definite boiling point and critical temperature. Its most marked feature is its inertness, for at either normal or high or low temperatures, it shows no sign of capacity to enter into combination. Mr. Crookes showed that it possesses two definite spectra, and that either can be put into evidence by the same specimens of the gas under different conditions. A very interesting point came out in the course of Professor Ramsay's remarks; about a century ago the presence of a peculiar constituent in the atmosphere, differing from phlogisticated air (nitrogen), and dephlogisticated air (oxygen), was indicated by Cavendish, who found it present to the extent of about $\frac{1}{120}$th of the volume of the air he experimented with. Thus the greatest discovery of modern times narrowly escaped detection 100 years ago. A discussion took place after the statement of the authors had been made, if discussion it can be called, that was chiefly a series of complimentary remarks addressed to the investigators. The Presidents of the Chemical and Physical Societies took conspicuous parts in this conversation, welcoming the discovery.

***

A New Speed Indicator for Cyclists.—A speed indicator for cyclists, which shows on a dial the speed of the machine at any moment, thus enabling the cyclist to know how fast he is going, has recently been invented in France. It is based on the principle of centrifugal force.

***

Mineral Pigments and Electricity.—Mineral pigments are now being made by electricity in much the same way as metals are deposited in electro-plating. A bath is prepared, and the electric current sent through it decomposes the chemical and produces the colour. Scheele's green, vermilion, mitis green, cadmium yellow, and Japanese red are the chief colours prepared in this way.

***

Petrie's Explorations on the Nile.—The recent excavations of Professor Flinders Petrie on the Nile have thrown a great deal of light on the earlier stages of Egyptian civilisation. The bronze age is shown to have been preceded by a copper age, and these again by a stone age, a period lasting for thousands of years, during which blades of chipped or polished flint and greenstone similar to those of prehistoric Europe were in use. His discoveries at Koptos during three months of last winter include a large number of stone implements, namely paleolithic celts of chipped flint and polished ones of greenstone, as well as cutting blades of flint. Some of these latter have serrated edges, and were fitted into a curved wooden frame to form a sickle for reaping corn, this curved frame being of similar shape to the jawbone of a cow with the teeth in it, which probably was the primitive sickle. Professor Petrie is desirous of establishing a British School of Archæology in Egypt, and proposes to send Mr. Quibell, an Oxford archæologist, to Egypt to excavate under his supervision during the coming winter, if his projected Egyptian Research Scheme receives sufficient support. Mr. Hilton Price, Director of the Society of Antiquaries, is the treasurer of the fund.

***

The Stereoscope and Coloured Photographs.—M. Nachet has recently brought out an instrument for showing coloured photographs in relief, to which he has given the name of the stereochromoscope. Three positive photographs of the object are taken with the red, blue, and yellow rays after the manner of Mr. Ives, of Philadelphia, previously detailed in these columns. These are placed in certain positions in the apparatus, and illuminated by light of the corresponding colour, red, blue, or yellow, and the luminous images thus obtained are blended into one. The effect of solidity is produced by the ordinary stereoscopic device.

***

Short Sight in Public Schools.—While in English public schools 20 per cent. of the pupils suffer from short sight, in the French public schools 24·2 per cent. of the scholars are short-sighted, and in those of Germany the percentage goes up to 35 per cent. French scientists are of opinion that want of physical exercise is at the root of this trouble, the hygienic condition of the school not seeming to affect the percentage. By modifying the work of the classes, the proportion of short-sighted scholars at the College of Giessen has fallen from 26·6 to 17 per cent. in five years.

***

A New Material for Diamond Borers.—M. Felix Fromholt has replaced the black diamond hitherto used for diamond borers and other useful implements with the crystalline diamonds not capable of being worked, which are called 'bort' in the trade. They come from Brazil.

***

The Deposition of Iridium by Electricity.—A method of depositing the metal iridium by electricity has been discovered by Dr. William Dudley. An oxide or a hydroxide of iridium insoluble in the bath, but soluble in the acid radical set free by the electric current at the anode or pole where the current enters the bath is employed. The oxide or hydroxide is contained in linen bags suspended in the bath between the carbon plates which form the anode. Pure iridium is deposited on the metal forming the cathode or pole where the electric current leaves the bath. Dr. Wahl has used the same process in depositing platinum.

***

The Italian Monument to Columbus.—Fourteen splendid volumes, a collection of all the contemporaneous documents relating to him, with essays by learned men of all countries on the disputed points of his career, will constitute the Italian monument to Columbus. The first two volumes will contain all his known writings and autographs, while the other volumes are to be taken up with his birth, family, and life. Genoa is pronounced to have been his birthplace, and his son Fernando is practically proved to have been legitimate. With regard to existing portraits of the great discoverer, the small panel now in the possession of Dr. Alessandro de Orchi of Como is admitted to be the only one possessing any pretension to authenticity, the others extant being mere copies or imitations. Diplomatic correspondence respecting Columbus, monographs on his precursors and successors, and a bibliography of works relating to him form a part of this comprehensive undertaking.

***

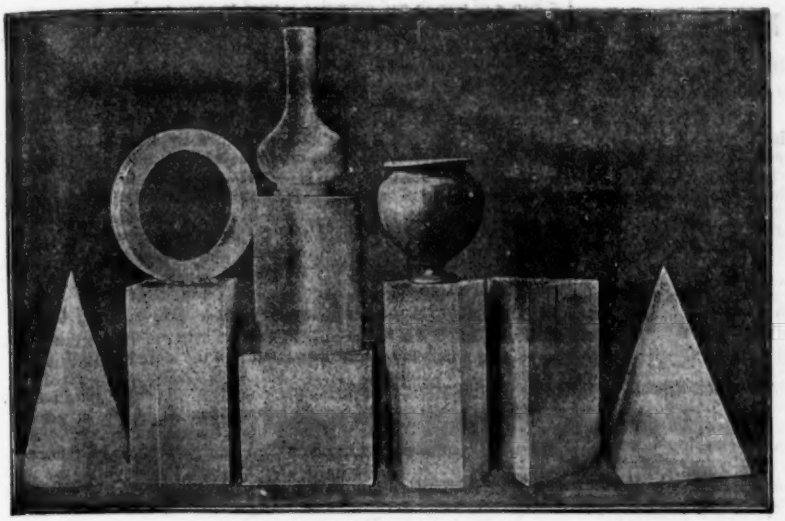
The Lines of Electric Force.—Professor Weiler, of Esslingen, gives a simple method of showing the lines of electric force between two electrodes or metal surfaces connected in an electric current. A milky mixture of triturated sulphate of quinine is prepared in oil of turpentine, and the electric discharges sent through it. In a little while a clear space is seen at the positive electrode, and particles of quinine cluster round the negative electrode arranged in streamers directed along the lines of electric force. Another experiment that can be easily performed by the amateur has been devised by Herr Bruno Kolbe. A quantity of pure anhydrous oil of turpentine is poured into a flat tray or vessel, and some sulphate of quinine stirred in it with a glass rod. The discharge from an electric influence machine is then sent through it by means of wires terminating in brass balls dipping into the turpentine. White crystals of quinine are then seen to arrange themselves in beautiful curving lines between the balls.

***

The Respiration of Leaves.—Maquenne has recently been investigating the subject of the respiration of leaves with the view of ascertaining, if possible, whether the evolution of carbon dioxide by plants is due, as in fermentation, to the splitting up of some compound previously oxidised, or whether it is the result of the combustion, pure and simple, of some principle continuously elaborated by the plant that oxidises on exposure to air. The hypothesis favoured by Maquenne was that according to which the living cell constantly secretes a combustible substance which by simple exposure to air oxidises and gives off carbon dioxide. By checking the action of the oxygen the product would accumulate, so that on the plant again being brought into contact with the air respiration would be increased accordingly. He compared the respiration of different kinds of leaves both in their normal state and after remaining previously for some hours in a vacuum. In each case the leaves were taken from the same plant, besides being of the same weight and as nearly as possible of the same age. As a result of the experiments Maquenne found that in all cases where the plant was able to resist the effects of the vacuum without undergoing appreciable alteration it afterwards disengaged a much larger quantity of carbon dioxide than it would have done had it simply been left exposed to the air.

***

Electric Resistances.—A good substitute has now been found for wire as a material for making very high resistances for electrical purposes, wire being both bulky and expensive. Herr Jona has introduced for this purpose an ebonite tube filled with graphite and unvulcanised indiarubber. The mixture is vulcanised, producing a highly resisting rod.



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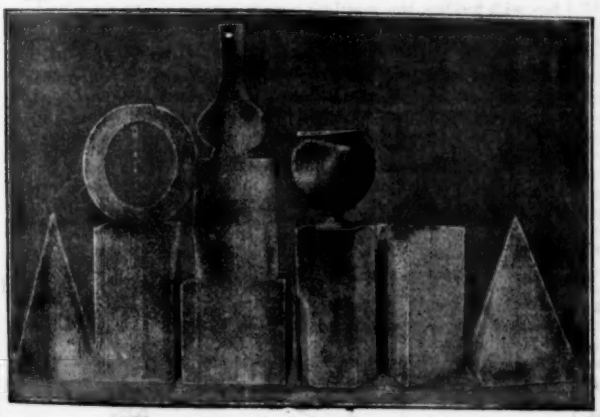

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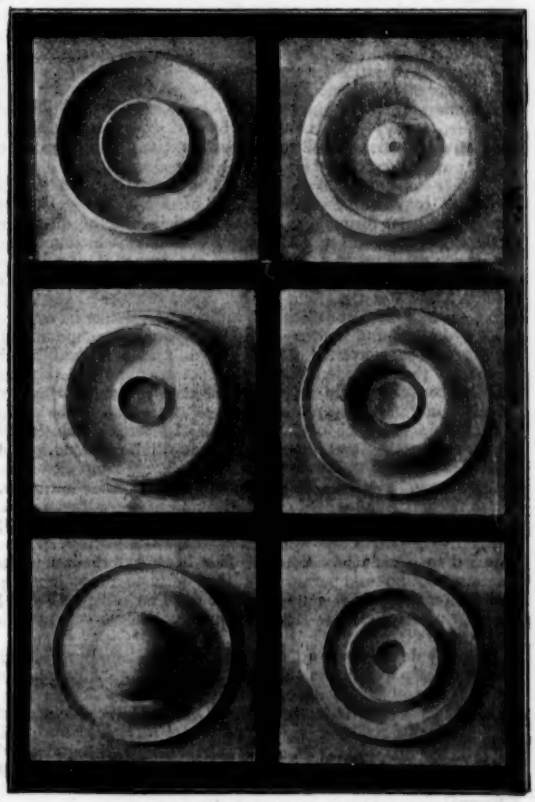

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ORGANIC CHEMISTRY NOTES.

By J. T. Hewitt, M.A., D.Sc., Ph.D.,
Professor of Chemistry, People's Palace Technical Schools.

The Aromatic Compounds are sharply divided from the fatty substances by the ease with which they give substitution derivatives; whereas alcohol yields a nitrate or sulphate by treatment with nitric and sulphuric acids respectively, phenol gives instead nitrophenols or phenolsulphonic acid. No phenyl nitrate is known, though Baumann has obtained the potassium salt of a phenylsulphuric acid by heating potassium phenolate with potassium disulphate in aqueous solution—

$$C_6H_5OK + K_2S_2O_7 = K_2SO_4 + C_6H_5.O.SO_3K.$$

Although this substance is stable enough towards alkalies, it is readily saponified by acids, yielding however, not the free phenylsulphuric acid, $C_6H_5.O.SO_2.OH$, but phenol and sulphuric acid; differing thus in a marked degree from ethylsulphuric acid, which is easy to isolate and which yields a long series of stable salts.

It follows from the constitution of benzene that only one monosubstitution derivative can be obtained; thus only one monohydroxybenzene (phenol) and one mononitrobenzene, etc., are possible. If, however, a benzene nucleus be already marked by the replacement of one hydrogen atom by some other group (*e.g.* OH, Cl, NO_2, SO_3H, etc.), the remaining hydrogen atoms have assumed unequal values. We have now two ortho-, two meta-, and one para-hydrogen atom left, so that it is possible to obtain any disubstituted benzene in three different isomeric modifications. Monochlorbenzene when nitrated yields a mixture of ortho- and para-chlornitrobenzenes, whilst by the action of chlorine on nitrobenzene the metachlornitrobenzene is obtained. We notice here that the group which is first introduced into a benzene molecule determines the position in which a second substituting group will enter; chlorbenzene, aniline, and phenol, for example, always yield a mixture of ortho and para disubstituted derivatives if nitrated, chlorinated, sulphonated, etc. On the other hand, nitrobenzene, benzoic acid, and benzene sulphonic acid give by further substitution metadisubstituted derivatives, possibly mixed in certain cases with small quantities of ortho and para. Various rules have been formulated for the prediction of the disubstitution derivatives which will result by acting on a monosubstituted benzene with some other reagent, and perhaps the best of these rules (which it must be remembered are purely empirical) is that given by Crum, Brown, and Gibson. (Jour. Chem. Soc., vol. 61, p. 367.) These chemists take the first substituent radicle and consider its compounds with hydrogen and hydroxyl. If the hydrogen compound of the radicle can be converted into the hydroxyl compound by direct oxidation, the monoderivative of benzene containing this radicle will be converted into a metadiderivative of benzene by further substitution; if, however, the hydrogen compound of the radicle is not capable of direct oxidation, then, by further substitution, a mixture of ortho- and para-derivatives will be formed. Taking examples of each case will render this clear; mononitrobenzene, for instance, gives metadinitrobenzene on further nitration, or metachlornitrobenzene on chlorination. The hydrogen and hydroxyl compounds of the nitro group are HNO_2 and $HONO_2$ respectively, and as we well know, nitrous acid may be directly oxidised to nitric acid. On the other hand, chlorbenzene yields a mixture of ortho- and para-diderivatives on further substitution; the hydrogen and hydroxyl compounds of the first radicle Cl are HCl HOCl, and hydrochloric acid cannot be converted into hypochlorous acid by direct oxidation.

Not only do the hydroxyl derivatives of the benzene series differ very markedly from those of the fatty series, but similar deviations are noticed amongst the nitro and amido derivatives. By reducing nitroethane, $C_2H_5NO_2$, ethylamine, $C_2H_5NH_2$, is obtained; similarly energetic reducing agents convert nitrobenzene into aniline, $C_6H_5NH_2$. In the latter case, however, various intermediate reduction products may be produced if the action is moderated; these generally contain the residues of two nitrobenzene nuclei, and are as follows:—

Azoxybenzene . . . $C_6H_5-N(\rightarrow O)-N-C_6H_5$.

Azobenzene . . . $C_6H_5-N=N-C_6H_5$.

Hydrazobenzene . . . $C_6H_5-NH-NH-C_6H_5$.

The best reducing agent to obtain azoxy compounds from nitro derivatives is sodium methylate. Klinger recommends the following process for the preparation of azoxybenzene: dissolve 10 parts of sodium in 250 parts of methyl alcohol, and add 30 parts of nitrobenzene. Boil the mixture in a flask provided with a reflux condenser for five or six hours, and distil off the methyl alcohol. This process is the one best fitted for the laboratory, but in factories a mixture of potash and glycerine is used to convert nitro compounds into the so-called 'Mikado' colours, which are azoxy compounds. The student should note that if azoxybenzene is warmed with strong sulphuric acid it undergoes an isomeric change, and is converted into oxyazobenzene (benzeneazophenol, $C_6H_5.N:N.C_6H_4OH$).

Azobenzene, $C_6H_5-N=N-C_6H_5$, may be prepared by adding some caustic soda solution, and then zinc dust, to an alcoholic solution of nitrobenzene; it may also be formed by a reverse process, oxidising a chloroform solution of aniline with bleaching powder.

Hydrazobenzene, $C_6H_5-NH-NH-C_6H_5$, is formed when an alcoholic solution of azobenzene is boiled with zinc dust, the colourless liquid is filtered and precipitated by water. Another way is to dissolve azobenzene in alcohol and then pass currents of ammonia and sulphuretted hydrogen through the solution. The ammonium hydrosulphide, NH_4SH, parts with some of its hydrogen, giving ammonium disulphide—

$$C_6H_5.N:N.C_6H_5 + 2NH_4SH = (NH_4)_2S_2 + C_6H_5.NH.NH.C_6H_5.$$

Hydrazobenzene has but weakly basic properties, and acids cause it to undergo a molecular transformation into the more basic benzidine or paradiamido-diphenyl, $NH_2.C_6H_4.C_6H_4.NH_2$. This reaction seems fairly general for hydrazo compounds in which the para positions to the —NH—NH— group are unoccupied. Cases in which the para position is occupied have been studied independently by Professors Jacobson and Otto N. Witt; their papers are to be found in the *Berichte* from 1892 onwards. Perhaps the simplest case is that described by Jacobson in his first paper; he subjects the paraethoxylazobenzene to the mild reducing action of stannous chloride in hydrochloric acid. This ethyl ether is prepared by the action of potash and ethyl iodide on benzeneazophenol, prepared by the interaction of diazobenzene chloride and sodium phenolate. Starting with aniline, the reactions may be represented by the following equations:—

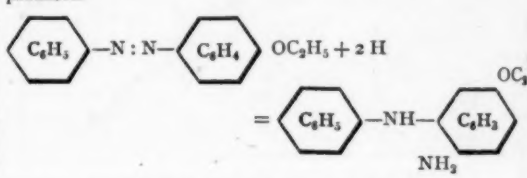
$$C_6H_5NH_2 + 2HCl + NaNO_2 = NaCl + 2H_2O + C_6H_5.N:N.Cl.$$

$$C_6H_5.N:N.Cl + C_6H_5ONa = NaCl + C_6H_5.N:N.C_6H_4OH.$$

The benzeneazophenol reacts with potash to form the potassium salt, and the ethyl iodide acts on this, giving the ethyl ester—

$$C_6H_5.N:N.C_6H_4OK + C_2H_5I = KI + C_6H_5.N:N.C_6H_4OC_2H_5.$$

The —N:N— and —OC_2H_5 groups occupying the para position relatively to one another, it is impossible to obtain a benzidine derivative by reduction; so when warmed with stannous chloride in hydrochloric acid solution, a derivative of ortho-phenylene-diamine is produced.



That this constitution is correct is shown by the fact that numerous internal condensation products can be produced by the action of various reagents, these containing another closed ring, of which the two nitrogen atoms are constituent members.

It has been recently shown that the reduction of nitrobenzene does not always lead to the linking up of two nuclei by means of the nitrogen atoms. Bamberger discovered that if nitrobenzene is boiled for a short time with water and zinc dust, the filtrate deposits long colourless needles of β-phenylhydroxylamine, which melts at 80°–81° (*Ber.* 27. 1347). Wohl (*Ber.* 27. 1432) describes very similar results, but recommends dissolving the nitrobenzene in 60% alcohol and adding 10% calcium chloride; the yield may in this way be raised to 75% of the nitrobenzene employed. Phenylhydroxylamine may be kept in dry air-tight vessels, but oxidation sets in if it is exposed to the air, and azoxybenzene is produced. The same substance is also formed together with azobenzene, aniline, and paramidophenol by heating to 100°. Paramidophenol is also readily formed by the action of acids, isomeric change taking place. Nitrous acid acts on phenylhydroxylamine, giving a nitrosamine of the formula $C_6H_5.N(NO)OH$; the compound also reacts readily with aldehydes.

The action of nitrous acid on the amines of the aromatic and fatty series yields different results. From a primary fatty amine and nitrous acid an alcohol is generally produced, nitrogen being eliminated; a secondary amine, such as diethylamine, gives a nitrosamine, *e.g.*, diethylnitrosamine $(C_2H_5)_2N.NO$, whilst nitrous acid is without action on tertiary fatty amines. In the case of aromatic compounds, the primary amines only yield a phenol at an elevated temperature; if the solution of an aromatic amido compound in an acid is cooled, and then treated with sodium nitrite, a diazo salt results. Recently Bamberger has described an isomer of diazobenzene, $C_6H_5.N:N.OH$, which he regards as phenylnitrosamine,

$C_6H_5.NH.NO$, since it does not yield an oxyazo dyestuff on treatment with a phenol. Hantzsch, however, considers that both compounds are diazo in constitution, the difference being stereochemical due to the arrangement of the groups connected with the two nitrogen atoms in space; the formulæ he gives are—

$$C_6H_5-N \qquad C_6H_5-N$$
$$HO-\ddot{N} \text{ and } \ddot{N}-OH$$

Hantzsch also claims to have prepared two potassium diazobenzene sulphonates, $C_6H_5.N:N.SO_3K$, the isomerism again depending on different spacial arrangements. Bamberger, however, looks on the difference as being structural, one salt being a sulphonate $C_6H_5.N:N.SO_3K$, the other a sulphite $C_6H_5.N:N.O.SO_2K$. Hantzsch's rejoinder to this is that both the potassium orthochlordiazobenzene sulphonates are stable salts, and even in extremely dilute solutions dissociate only into two ions, as if they were both sulphonates; a sulphite of potassium and diazobenzene he contends would give three.

The secondary aromatic amines behave towards nitrous acid in the same way as the secondary fatty amines yielding nitrosamines. These nitrosamines show a marked divergence from their fatty analogues in one respect, they suffer a molecular change under the influence of strong mineral acids. Methylphenylnitrosamine, for example, yields in this way paranitrosomethylaniline, $NO.C_6H_4.NHCH_3$.

In the tertiary amines the divergence is very marked, dimethylaniline dissolved in hydrochloric acid yields a precipitate of nitrosodimethylaniline hydrochloride, $NO.C_6H_4.N(CH_3)_2$, HCl when a solution of sodium nitrite is added.

Practical Notes.—The detection of the elements of which an organic compound is built up is an important matter. Separation of carbon usually takes place on direct heating, but oxalic acid and many oxalates do not blacken: consequently the best proof of the presence of carbon in a compound is to heat the substance in a dry test tube with freshly ignited copper oxide. The carbon is thus burnt to carbon dioxide, which may be detected in the usual way by passing into lime-water, whilst if moisture is deposited on the cool part of the tube, hydrogen was also present in the substance.

Many nitrogenous organic compounds give off ammonia on ignition with soda lime, but this is far from generally applicable, as the nitro and some of the azo substances will not react in this way. Consequently it is better to use the method of Lassaigne, which consists in heating the substance in a narrow tube with a small piece of sodium; this combines with the nitrogen and some of the carbon to form sodium cyanide. After cooling and addition of water (take care if an excess of sodium has been used!) a mixture of ferrous and ferric salts and a little caustic soda are added; warm gently, and then acidify with hydrochloric acid. If a residue of Prussian Blue is found, nitrogen was present in the original substance; the sodium cyanide reacted with the ferrous salt to form sodium ferrocyanide, which gave the Prussian Blue on reacting with the ferric salt.

The presence of halogen in an organic compound is very readily detected by heating a piece of copper oxide wrapped in the end of a piece of platinum wire in the bunsen flame, until it no longer communicates any colour to it. Now touch the copper oxide with some of the substance to be tested, and heat once more in the flame; if this is now coloured green, a halogen was present. Beilstein says that some idea of the quantity of halogen present may be drawn from the duration of the green coloration.

Schönn's method of detecting sulphur in an organic compound is the easiest to carry out. Heat some of the substance with sodium in a small thin-walled test tube; when the mass is cold, introduce it into acidified water. The sodium sulphide which was formed during the heating is now decomposed with evolution of H_2S. Instead of this, the ignited mass may be put into a solution of sodium nitro prusside (violet coloration).

A modification of this method serves for the detection of phosphorus. Heat the substance in a test-tube with magnesium filings; when cold, add a little water. A smell of onions, due to evolution of hydrogen phosphide, will be observed; if the water be added in the dark, the tube will appear illuminated.

Most metals are left as oxides or carbonates when their organic compounds are heated; some, such as gold, silver, and platinum, are left in the free state. Lead compounds usually give a mixture of reduced metal and oxide on heating. Elements such as mercury, cadmium, and arsenic, which are readily volatile, are best detected after destroying the organic portion by heating with fuming nitric acid, preferably in a sealed tube.

Remarks on Last Month's Questions.—1. The three xylenes or dimethylbenzenes are to be distinguished as ortho, meta, and para. There is only one methylbenzene or toluene; a second methyl group can enter either in the ortho-, meta- or para-position with respect to this.

2. Nitrobenzene is prepared from benzene by adding it to a cold mixture of nitric and sulphuric acids; the nitrobenzene is afterwards separated by addition of water, then dried and fractionated. The nitrobenzene may in turn be converted into aniline by reduction with granulated tin and strong hydrochloric acid; to obtain the free base, add caustic soda in excess and distil in a current of steam. Separate the two components of the distillate, water and aniline, dry the latter with fused caustic potash (not fused calcium chloride), and fractionate. Aniline can best be converted into phenylhydrazine by Victor Meyer and Lecco's method. The aniline is dissolved in an excess of fuming hydrochloric acid, well cooled, diazotised by addition of the calculated quantity of sodium nitrite dissolved in a small quantity of water, and then reduced to phenylhydrazine hydrochloride by addition of a well-cooled solution of stannous chloride in fuming hydrochloric acid—

$$C_6H_5.N:N.Cl + 4HCl + 2SnCl_2 = 2SnCl_4 + C_6H_5.NH.NH_2,HCl.$$

The pasty crystalline mass of crystals is separated, dissolved in warm water, strong potash added in excess, and the free hydrazine extracted with ether. The ethereal solution is dried, the ether distilled off, and finally the phenylhydrazine, preferably in vacuo.

The student is advised to make these three preparations; details as to quantities, precautions, and yields to be expected are given in Fischer's 'Organic Preparations,' of which there is an English edition.

Phenylhydrazine is used as a reagent for detecting the —CO— group in aldehydes and ketones. Shake up a few drops of benzaldehyde with a solution of phenylhydrazine to which some sodium acetate has been added, a crystalline precipitate of benzalphenyl hydrazone, $C_6H_5.CH:N.NH.C_6H_5$, separates.

3. An *amine* is ammonia in which one or more hydrogen atoms have been replaced by alkyl groups, *e.g.*, ethylamine $NH_2C_2H_5$, dimethylamine $NH(CH_3)_2$. An *amide* is derived from ammonia by replacement of hydrogen with acid radicles, *e.g.*—

$$\text{Carbamide } CO\begin{matrix}/NH_2\\ \backslash NH_2\end{matrix} \qquad \text{Acetamide } CH_3.CO.NH_2.$$

An *amido acid* is an acid in which one or more hydrogen atoms of the hydrocarbon nucleus have been substituted by NH_2 (amidogen) groups, *e.g.*, $NH_2.CH_2.COOH$, amidoacetic acid; $C_6H_3(NH_2)_2COOH$, diamidobenzoic acid. (Note that an acid amide is to be regarded as derived from an acid by replacement of acidic OH by NH_2.) For glycocoll, see Bernthsen's 'Organic Chemistry,' p. 227.

4. Nitro-glycerine is not a nitro compound, it is a nitrate formed by the action of nitric acid on the triatomic alcohol glycerine $C_3H_5(OH)_3$. Nitro-naphthalene is a nitro compound, formed by replacement of H by NO_2; on reduction it yields amidonaphthalene or naphthylamine.

Honours Questions.—1 and 2. See notes for January and February. 3. The chief method practically employed for the determination of the molecular weight of non-volatile substances is that of Raoult as modified by Beckmann, depending on the lowering of freezing point of a solution due to dissolved substance; for a sketch of apparatus see Ostwald's 'Outlines of General Chemistry,' p. 137. Other methods depend on the raising of the boiling point of a solution and on the osmotic pressure of a solution. 4. Read Bernthsen's Chemistry, p. 260 *et seq.*

MATHEMATICS.

STAGES 2 AND 3, SCIENCE AND ART DEPARTMENT.

By G. A. Baxandall,

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Stage 2.

Algebra.

Read Arts. 323, 324, 325 to 328, H.S., and observe the paragraphs (3) and (4) in the last article; *or* Arts. 335, 339, 340, H.K., and observe carefully the worked-out examples. Art. 340 is most important; observe the results marked (i) and (ii).

Example.—If α and β be the roots of $x^2+px+q=0$, show that $\alpha^3+\beta^3=p(3q-p^2)$.

Now $\alpha+\beta=-p$, and $\alpha\beta=q$; these two equations are all we have to work from.

Now $\alpha^3+\beta^3=(\alpha+\beta)(\alpha^2-\alpha\beta+\beta^2)$

$=-p[(\alpha+\beta)^2-3\alpha\beta]$

$=-p(p^2-3q)=p(3q-p^2)$.

Example.—If the roots of $x^2 - px + q = 0$ are two consecutive integers, prove that $p^2 - 4q - 1 = 0$.

Let a and $a+1$ be the roots, then $a + a + 1 = p$, and $a(a+1) = q$, so that $p^2 - 4q - 1 = (2a+1)^2 - 4a(a+1) - 1$, and this $= 0$.

Work the following examples :—

27. If α, β, are the roots of $px^2 + qx + r = 0$, show that $\alpha^2 + \beta^2 = \frac{q^2 - 2pr}{p^2}$.

28. Form an equation having for its roots the squares of the roots of $ax^2 + bx + c = 0$.
Ans. $c^2x^2 - (b^2 - 2ac)x + c^2 = 0$.

29. If α, β, are the roots of the equation $x^2 - px + q = 0$, prove that
$$(x - \alpha)(x - \beta) = x^2 - px + q ;$$
and from the equation, with coefficients in terms of p and q, of which the roots are $\frac{1}{\alpha}, \frac{1}{\beta}$. Ans. $qx^2 - px + 1 = 0$.

30. Form the quadratic equation whose roots are 7 and 10.

If the roots of $x^2 - px + q = 0$ are two consecutive integers, prove that $p^2 - 4q - 1 = 0$. Ans. $x^2 - 17x + 70 = 0$.

31. Form the equation of which the roots are $3 + 2\sqrt{-1}$ and $3 - 2\sqrt{-1}$. Ans. $x^2 - 6x + 13 = 0$.

32. If α and β are the roots of the equation $x^2 + px + q = 0$, express $\alpha^3 + \beta^3$ and $\alpha^5 + \beta^5$ in terms of p and q.
Ans. $p^3 - 2q ; 5pq - p^5$.

Read the chapter on Ratio and Proportion in H.S. or H.K., carefully observing the definitions of antecedent and consequent, compound ratio, duplicate and triplicate ratios, continued proportion, mean proportional, and third proportional. A large number of examples on Proportion are worked out in the manner shown on pp. 250, 251, H.S., which should be carefully read ; *or* in Ex. 1, H.K., p. 265. The student must make himself perfectly familiar with this method, and apply it to work out the following :—Exs. CXXXI., H.S., Nos. 2, 3, 6, 11, 14 ; or Exs. XXXIII*b*, H.K., Nos. 14, 16, 18.

Example.—If a, b, c, d, are in continued proportion, prove that $a : d = a^3 + b^3 + c^3 : b^3 + c^3 + d^3$.

Let $\frac{a}{b} = \frac{b}{c} = \frac{c}{d} = k$, then $a = bk$, $b = ck$, $c = dk$, so that by multiplying we get $abc = bcdk^3$, or $a = dk^3$, *i.e.*, $\frac{a}{d} = k^3$.

Now $\frac{a^3 + b^3 + c^3}{b^3 + c^3 + d^3} = \frac{b^3k^3 + c^3k^3 + d^3k^3}{b^3 + c^3 + d^3} = k^3 = \frac{a}{d}$

Work the following :—

33. If $a : b :: c : d$, and $m : n :: p : q$, show that
$$ma + nb : ma - nb :: pc + qd : pc - qd.$$
If $\frac{x}{b-c} = \frac{y}{c-a} = \frac{z}{a-b}$, show that either fraction equals
$$\frac{(x+y)+(y+z)}{c-a}.$$

34. What is the triplicate ratio of $a : b$?

Find the number that must be subtracted from the antecedent and consequent of the ratio 3 : 5, so that the resulting ratio may equal the triplicate ratio of 4 : 5. Ans. $\frac{55}{61}$.

35. If $\frac{a}{b} = \frac{c}{d} = \frac{e}{f}$, prove that $\frac{a}{b} = \ldots = \sqrt{\frac{(3c^2 + 4e^2)}{(3d^2 + 4f^2)}}$.

36. Find two numbers in the ratio of $1\frac{1}{2} : 2\frac{3}{4}$, such that, when increased each by 15, they shall be in the ratio of $1\frac{3}{4} : 2\frac{1}{2}$.
Ans. 27, 48.

37. If $\frac{x+z}{y} = \frac{z}{x} = \frac{x}{x-y}$, determine the ratios $x : y : z$.

Also when four quantities of the same kind are proportional, show that the greatest and least of them together are greater than the other two together. Ans. 2 : 3 : 4.

Trigonometry.

We have already observed that in the common system of logarithms the number 10 is selected as the base. Sometimes, however, we require to find the logarithm of a number to some different base. This can always be done by means of a rule stated and proved in Art. 155, H.S., or Art. 209, Lock.

In some simple cases it may be done by simply observing the definition of a logarithm. For example, required log 16 to base 2. Now $16 = 2^4$, hence from the definition, 4 is the log of 16 to base 2.

What is log 16 to base 8? Since $16 = 2^4 = \left(8^{\frac{1}{3}}\right)^4 = 8^{\frac{4}{3}}$, then $\frac{4}{3}$ is the log of 16 to base 8. What is log 144 to base $2\sqrt{3}$? Since $144 = (2\sqrt{3})^4$, then 4 is the log of 144 to base $2\sqrt{3}$.

Work out the following :—

25. Find log 64 to base 16 ; log 27 to base 9 ; log 16 to base $2\sqrt{2}$. Ans. 1·5 ; 1·5 ; $\frac{8}{3}$.

26. Find log $12\sqrt{3}$, having given log 4·32 = ·6354837.
Ans. 1·3177418.

27. Find (1) the characteristic of log 54 to base 3.
(2) log $(\cdot 0125)^{\frac{3}{3}}$
(3) number of digits in 3^{45}
Given log 2 = ·30103.
log 3 = ·47712.
Ans. 3 ; $\bar{1}$·36564; 22.

28. Given log 8 = ·9030900, log 28 = 1·447158, find the logarithms of 50 and 350. Ans. 1·69897 ; 2·544068.

Example.—Prove that $7 \log \frac{15}{16} + 6 \log \frac{8}{9} + 5 \log \frac{2}{5} + \log \frac{243}{250} = \log 3$.

The numbers entering into this example are such as can be expressed in terms of 2 and 3. We shall obtain a solution by making use of the rule for the logarithm of a product.

The left hand
$$= 6 \log \tfrac{15}{16} + 6 \log \tfrac{8}{9} + 5 \log \tfrac{2}{5} + \log \tfrac{243}{250} + \log \tfrac{15}{16}$$
$$= 6 (\log \tfrac{15}{16} + \log \tfrac{8}{9}) + 5 \log \tfrac{2}{5} + \log \tfrac{243}{250} + \log \tfrac{15}{16}$$
$$= 6 \log (\tfrac{15}{16} \times \tfrac{8}{9}) + 5 \log \tfrac{2}{5} + \log (\tfrac{243}{250} \times \tfrac{15}{16})$$
$$= 6 \log \tfrac{5}{6} + 5 \log \tfrac{2}{5} + \log \tfrac{9}{8}$$
$$= 5 (\log \tfrac{5}{6} + \log \tfrac{2}{5}) + \log \tfrac{5}{6} + \log \tfrac{9}{8}$$
$$= 5 \log 1 + \log (\tfrac{5}{6} \times \tfrac{9}{8}) = 0 + \log 3.$$

Read Chap. XV., H.S., or Chap. XV., Lock, and work from the examples on these chapters.

The subject-matter contained in these chapters is of the greatest importance, as it is essential for the solution of triangles. It is so carefully treated in each of the two text-books, that it is unnecessary to add anything here. We shall, however, work one example by way of illustration.

Example.—Find the common logarithm of tan 58° 5′ 45″, having given L tan 58° 5′ = 10·2056173, and L tan 58° 6′ = 10·2058939.

The required logarithm lies between the two given ones ; let it $= 10{\cdot}2056173 + x$; then subtracting the *least* angle from each of the other two, we get the differences 45″ and 60″ ; subtracting the *least* logarithm from each of the other two, we get x and ·0002816. Now the 'principle of proportional parts' tells us that $\frac{x}{\cdot 0002816} = \frac{45}{60} = \frac{3}{4}$, from which x is found to be ·0002112, and L tan 58° 5′ 45″ = 10·2058285. This is the *tabular* logarithm of tan 58° 5′ 45″ ; the *true* logarithm would be ·2058285. One source of error in these examples lies in the fact that, as the angle increases (from 0° to 90°), the logarithms of some of the ratios increase, while others decrease, the *tangent*, *sine*, and *secant* belonging to the former class, and the *cotan*, *cosine*, and *cosec* to the latter.

Example.—Find the numerical value of the cube root of (tan 52° 40′) ÷ 15, having given L tan 52° 40′ = 10·1176373, log 2 = ·3010300, log 3 = ·4771213, log 44380 = 4·6471873, log 44379 = 4·6471775.

Let $x = \sqrt[3]{\frac{\tan 52° 40'}{15}}$.

Then $\log x = \frac{1}{3}$ [log tan 52° 40′ − log 15]
$= \frac{1}{3}$ [L tan 52° 40′ − 10 − (log 3 + log 5)]
$= \frac{1}{3}$ [10·1176373 − 10 − (log 3 + log 10 − log 2)]
$= \frac{1}{3}$ [·1176373 − 1·1760913] = $\frac{1}{3}$ (− 1·0584540)
$= \frac{1}{3}$ (2·9415460) = $\bar{1}$·6471820.

Now log	·44380 = $\bar{1}$·6471873		$\bar{1}$·6471820
log	·44379 = $\bar{1}$·6471775		$\bar{1}$·6471775
Difference	·00001	·0000098	·0000045

$\therefore x = {\cdot}44379 + \frac{45}{98}$ of ·00001 = ·4437946.

Work the following :—

29. Find the logarithm of the tangent of 81° 11′ 45″, and the angle whose L cotan is 9·6170456.

30. Find the numerical value of $\sqrt{(\tan 50^\circ . \tan 22^\circ 30')}$.

31. Find the numerical value of $\sqrt{\frac{1}{3}\sin 44^\circ}$.

The logarithms for the above examples are to be taken from the following :

L tan 81° 11′ = 10·8093713	L sin 44° = 9·8417713
,, 81° 12′ = 10·8102061	log 3 = ·4771213
,, 22° 29′ = 9·6168669	log 61407 = ·7882179
,, 22° 30′ = 9·6172243	6 = ·7882108
,, 50° = 10·0761865	,, 79032 = ·8978030
	3 = ·8978085

Answers. (29) 10·8099899 ; 67° 30′ 30″ ; (30) ·79032109 ; (31) ·6140635.

Geometry.

Read Propositions 11 to 18, Book III.

5. Show that the hypotenuse of a right-angled triangle, together with the diameter of the inscribed circle, equals the sum of the sides containing the right angle.

6. Given two points, show how to draw a circle with one of the points as centre, such that its diameter shall equal the tangent drawn to it from the other point.

7. A and B are two fixed points without a circle PQR ; it is required to find a point P in the circumference, so that the sum of the squares described on AP and BP may be the least possible.

8. O is the centre of a circle, P is any point in its circumference, PN a perpendicular on a fixed diameter ; show that the straight line which bisects the angle OPN always passes through one or the other of two fixed points.

SOLUTIONS TO QUESTIONS IN THEORETICAL MECHANICS.

BY F. CASTLE, M.I.M.E.

Continued from p. 448.

25. A bottle filled with water weighs 37·5 oz. ; when filled with a liquid whose specific gravity is 0·96, it weighs 36·3 oz. ; find the weight of the bottle. (20)

Let V = volume of water in the bottle.
w = weight of unit volume of water.
W = weight of the bottle.

Then total weight of bottle and contents will be—
When filled with water, $V \times w + W$;
When filled with the given liquid, $V \times \cdot 96 \times w + W$.

Hence $V \times w \times W = 37\cdot5$; (1)

also $V \times \cdot 96 \times w + W = 36\cdot3$ (2)

Subtracting equation (2) from equation (1), we obtain—

$$\cdot 04\, V \times w = 1\cdot 2.$$

$$\therefore V \times w = \frac{1\cdot 2}{\cdot 04} = \frac{120}{4} = 30. \quad (3)$$

Substituting from eq. (3) in (1)—

$$\therefore 30 + W = 37\cdot 5 ;$$

$$\text{or } W = 37\cdot 5 - 30$$

$$= \underline{7\cdot 5 \text{ ozs.}}$$

26. Define the whole pressure of a liquid on a surface.

A hollow cone filled with water is held with its vertex downward and axis vertical ; the length of the axis is 12 ft., and the radius of the base is 5 ft. ; find the whole pressure on its surface.

State the rule by which the whole pressure on a surface is found. (20)

The whole pressure of a liquid on a surface is the sum of all the normal pressures exerted by the liquid on every unit of area of the surface.

Length of sloping side of cone $= \sqrt{5^2 + 12^2} = 13$ ft.

Area of curved surface of cone $= \frac{5 \times 2 \times \pi \times 13}{2}$

$= 5 \times 13 \times \pi$ sq. ft.

The centre of gravity of surface is at a depth of 4 ft.

$\therefore$ Whole pressure $= 5 \times 13 \times \pi \times 4 \times 62\frac{1}{2}$.

$= \underline{51{,}051 \text{ lbs.}}$

Weight of a cubic ft. of water $= 62\frac{1}{2}$ lbs.)

The whole pressure is equal to the weight of a right prism of the liquid whose base is equal in area to the given surface, and whose height is equal to the depth of the centre of gravity of that surface below the surface of the liquid.

27. A vessel contains two liquids that do not mix, and a cylinder floating with its axis vertical ; the lighter liquid is 6 in. deep, and its specific gravity is 0·75 ; the specific gravity of the heavier liquid is 1·05 ; one inch of the height of the cylinder is above the upper liquid. If the specific gravity of the cylinder is 0·8, what is its height ? (25)

Let A = area of cross-section of cylinder ; l = length of cylinder ; w = weight of unit volume of water.

Then weight of cylinder $= A \times l \times \cdot 8 \times w$.

If the cylinder sinks into the heavier liquid to a distance x. then resultant vertical pressure acting upwards

$$= (6 \times \cdot 75 \times A + x \times 1\cdot 05\, A)\, w.$$

Hence for equilibrium we have

$$w(A \times l \times \cdot 8) = w(6 \times \cdot 75 + x \times 1\cdot 05)\, A.$$

$$\therefore l \times \cdot 8 = 4\cdot 50 + 1\cdot 05\, x,$$

but $x = l - 7$.

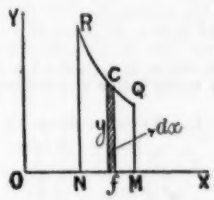
$$\therefore \cdot 8l - 1\cdot 05\,(l - 7) = 4\cdot 5.$$

$$\therefore l = \frac{285}{25} = \underline{11\frac{2}{5} \text{ inches.}}$$

$\therefore$ Length of cylinder is $11\frac{2}{5}$ inches.

28. A given quantity of gas has a volume V, under a pressure P, at given temperature : if its volume becomes v without change of temperature, show that the work done by the gas during expansion is $VP \log \frac{v}{V}$.

Under what circumstances will this formula give the work done in foot-pounds ? (25)



Take two lines OY, OX at right angles to each other, and let distances measured along the axis OX represent volumes and those measured along OY represent pressures. Since the temperature is constant, the pressure multiplied by the volume is constant by Boyle's Law, and the curve representing changes in pressure and volume is a rectangular hyperbola.

Let RQ represent a portion of the curve where ON = V, OM = v, NR = P, MQ = p. Then $PV = pv$ = constant = c.

Work done by the gas in expanding from vol. x to vol. $x + dx$ ($of = x$, and $fc = y$) is ydx, where y is the pressure when vol. is $x + dx$.

$\therefore$ Total work done by gas in expanding from vol. V to vol. v

$$= \int_V^v y\,dx = \int_V^v \frac{c\,dx}{x}$$

$$= c \log_e \frac{v}{V} = \text{PV} \log_e \frac{v}{V}.$$

The formula gives the work done in foot-pounds when P represents pounds per sq. ft., and v and V are volumes in cubic feet.

29. A hollow cylindrical vessel is filled with gas at a given pressure ; explain what is meant by t in the formula, $t = pr$.

Suppose the cylinder to be 4 ft. high, and the radius of its base to be 6 in. ; what would be the whole tension along one generating line, if the pressure of the gas were 4 lbs. per square inch ? (*i.e.*, in excess of external pressure, if any. (20)

The formula $t = pr$ gives the relation between the tension per unit length and the pressure and radius of cylinder.

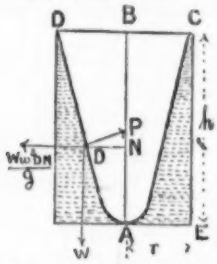
$\therefore t$ is the tension per unit length.

$\therefore t = 4 \times 6 = 24$ lbs.

Hence whole tension along a generating line $= 24 \times 4 \times 12$

$= \underline{1{,}152 \text{ lbs.}}$

30. A cylindrical vessel is half-full of water ; it revolves about its axis, which is vertical, with a constant angular velocity ; find the velocity when the water just rises to the rim of the vessel. (30)



If a cylindrical vessel partly filled with water be whirled round a vertical axis AB, coinciding with the axis of the vessel, and at uniform velocity, the water will be hollowed out into the form of a cup, the surface being that known as a paraboloid of revolution.

Let ω denote the angular velocity, and D a particle on the surface ; draw DP perpendicular to the surface meeting the axis at P, and DN perpendicular to and meeting the axis at N.

The forces acting on the particle are (1) its weight, (2) $\frac{W}{g}\omega^2 \times DN$, (3) fluid pressure at D ; also force (3) is the resultant of (1) and (2) and must act in DP.

Hence $PN : DN = W : \frac{W\omega^2 \times DN}{g}$;

$$\therefore PN = \frac{g}{\omega^2};$$

this gives the subnormal PN to be constant, hence the curve is a parabola. ∴ the surface (CADD^1 being the cross section) is a paraboloid, and it is a property of the paraboloid that its volume is one-half that of the circumscribing cylinder, hence when a mass of liquid is rotated in a cylindrical vessel the vertex A falls as much below the original level as the edge C rises above it.

Let the radius BC $= r$;
,, ,, height CE $= h$;
the curve is such that the following relation holds good :—

$$\omega^2 \times r^2 = 2g \times h ;$$

$$\therefore \omega = \frac{1}{r}\sqrt{2gh}$$

(from which the velocity can be found).

31. Show that the work done in expanding a soap bubble from radius a to radius b equals $4\pi\ (b^2 - a^2)\ t$.

Why is t, the tension of the film, constant ? (30)

In a soap bubble the outside is exposed to atmospheric pressure, and the inside to a pressure somewhat greater, the difference of the pressures being balanced by the tendency of the film to contract.

Let p denote the difference between the internal and external air-pressures, and t the tension of the film of a soap bubble of radius r. Then $2t = pr$. (1) Work done in expanding a soap bubble from radius r, to a radius r^1 where r^1 is slightly greater than r, is $p \times 4\pi r^2\ (r^1 - r)$; this equals $8\pi tr\ (r^1 - r)$ from (1). Hence, if t be constant, the total work done in the formation of a bubble of radius R will be

$$\int_0^R 8\pi tr\,dr \quad \text{(when } r^1 - r \text{ is made indefinitely small)}$$

$$= 4\pi t R^2. \quad (2)$$

The result can also be obtained as follows :—

The work done will be the sum of a series of terms of form $8\pi tr\ (r^1 - r)$.

Let $r^1 - r = \frac{R}{n}$ and $r = \frac{mR}{n}$;

$$\therefore \text{Work done} = 8\pi t \Sigma_1^n \frac{mR^2}{n^2}$$

$$= 4\pi t R^2 \text{ (when } n \text{ is indefinitely increased).}$$

∴ Work done in the formation of a bubble radius $b = 4\pi tb^2$.

,, ,, ,, ,, ,, ,, ,, $a = 4\pi ta^2$.

∴ Work done in expanding a soap-bubble from radius a to radius $b = 4\pi\ (b^2 - a^2)\ t$.

Hence when the area of the surface is increased work must be done. Also if the result (2) be divided by the area of the surface, we find the superficial energy is equal to t, or the superficial tension per unit of length is equal to the superficial energy per unit of area. But this is a constant for the two given fluids, therefore the tension in a soap-bubble is constant, is the same in all directions, and remains the same however much the film is extended.

32. If an undulatory disturbance is transmitted along a tube, and the displacement of a particle is represented by the formula—

$$a \sin \frac{2\pi}{\lambda}(vt - x),$$

what is denoted by the letters a, λ, v, t, x ?

P and Q are two fixed points in the tube ; find from the formula the time it takes the disturbance to pass from P to Q ; and hence show that v has the meaning you have assigned to it. (25)

a is the amplitude, or maximum vibration of any particle.
λ is the wave length.
v is the velocity of propagation of the wave.
t is the time of vibration.
x is the original distance of any point (or the distance of any particle before displacement) from some fixed point.

And the formula $a \sin \frac{2\pi}{\lambda}(vt - x)$ is an expression for the disturbance when one undulation only (consisting of an indefinite number of similar waves) is considered.

The time it takes the disturbance to pass from P to Q (as the terms in the equation are known) can easily be determined.

For further information on this and preceding question the student is referred to 'Besant's Hydrostatics.'

MAGNETISM AND ELECTRICITY.

FOR THE ADVANCED STAGE OF THE SCIENCE AND ART DEPARTMENT COURSE.

BY EDWIN EDSER, A.R.C.S.

Assistant in the Physical Laboratory, Royal College of Science ; Member of the Physical Society.

Electro-Magnetic Units.

IT now becomes necessary to define the units of current, etc., adopted in electrical measurements. These are founded on the experimental law that the force acting on a magnetic pole placed near a short wire through which a current flows, is proportional to the strength of the magnetic pole, the length of the wire, and the current flowing through it ; and is inversely proportional to the square of the distance between the wire and the pole. Expressing this in mathematical symbols, we have

$$f = \frac{mCl}{r^2},$$

where f = force on pole,
m = magnetic strength of do.,
C = current flowing through wire of length l,
r = distance between the wire and the pole.

Now suppose a wire to be bent into a circle of radius r, and that a current represented by C flows through it ; then each element of the wire will be at a distance r from the centre, so that the total force acting on a pole of strength m placed at the centre would be

$$\frac{mC \times 2\pi r}{r^2} = \frac{2\pi Cm}{r}.$$

If, however, 1 centimetre of wire be bent into an arc of a circle of 1 centimetre radius, the force at the centre would be

$$f = \frac{mC \times 1}{1}.$$

This leads to the definition of *unit current*, viz., *that current which, flowing through a piece of wire 1 c.m. in length, bent into the arc of a circle of 1 c.m. radius, exerts a force of 1 dyne on a unit magnetic pole when placed at the centre of the circle.*

It will be noticed that this definition depends on the definition of a unit pole, which we have already considered, viz., *a unit pole exerts a repulsive force of one dyne on a similar pole placed at 1 c.m. distance from it.*

The other electro-magnetic units proceed at once from these. Thus the work done in bringing a quantity Q of electricity against an electro-motive force E = EQ, and Q = Ct, where C = current and t = the time that it has been flowing.

∴ Work = ECt.

Now if unit current (as above defined) flow for second, we shall have

Work = E × I × I, therefore we define the *unit electro-motive forces between two points on a circuit as that which, when unit current flows for unit time, performs one erg of work.*

Then for the unit of resistance, we have the relation, often spoken of as 'Ohms Law,'

$$C = \frac{E}{R},$$

R being the resistance, C and E having the same meaning as formerly. *Unit Resistance is then defined as such that when unit electro-motive force is maintained between its ends, unit current flows through it.* These three units, of current, of electro-motive force (E.M.F.), and of resistance, are the most important units used in electrical measurements. The unit E.M.F. is often spoken of as unit difference of potential; but the student who has grasped the idea of potential will have no difficulty in distinguishing the error of this system of nomenclature. Difference of potential is really *work* done between two points, in driving a current *against an E.M.F.* between them. However, this term is often used as above indicated, and the student should be careful to remember what is really meant by it when so used.

For practical purposes, however, the units described above are not of convenient size. As a result, derived units have been adopted as follows :—

The *Volt* = 100,000,000 units of E.M.F. as above defined. To avoid loss of time and space, the above figure is generally expressed as 10^8.

The *Ohm* = 10^9 units of Resistance.

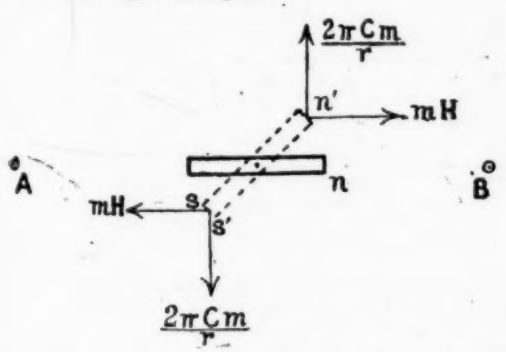
The *Ampère* = $\frac{1 \text{ Volt}}{1 \text{ Ohm}} = \frac{10^8}{10^9} = 10^{-1}$ (or $\frac{1}{10}$) of an unit of current.

Electro-Magnetic Measurements.

The student will more readily grasp the significance of the above units when the methods of making some measurements based on them are understood. We shall first consider two methods of measuring currents, by the Tangent Galvanometer, and by Lord Kelvin's Current Balance.

The tangent galvanometer consists essentially of a circular ring of copper wire, fastened to a stand so that its axis is horizontal, a small magnet being hung by a fine torsionless fibre at its centre. The magnet will of course take up a north and south position, and the circular ring of wire is turned round till its place contains the axis of the magnet.

When a current C flows through the wire, let us see what will be the effect on the suspended magnet.



Suppose A and B to be the sections of the circular ring of wire by a horizontal plane, and that the current is flowing up at A and down at B. Then *n* will be acted on by a force

$$= \frac{mC \times 2\pi r}{r^2} = \frac{2\pi Cm}{r}$$

(C, *m*, and *r* having the meanings we have previously assigned to them) in a westerly direction, whilst *s* will be acted on by an equal and opposite force. These two forces will produce a couple tending to turn the magnet towards the dotted position shown in the figure.

But directly the magnet moves from its position of rest in the earth's field, the latter will begin to exert forces on its poles. These will be of a magnitude = *m*H (H being the strength of the earth's field at the point), and will tend to restore the magnet to its previous position. When a position of rest has been reached, the two couples must equilibrate each other.

Now, couple due to magnetic effects of current flowing through the wire

$$= \frac{2\pi Cm}{r} \times l \cos \theta,$$

l being the length of the magnet, and θ its angular deflection. Similarly, couple due to earth's field = *m*H *l* sin θ.

For equilibrium

$$mHl \sin \theta = \frac{2\pi Cm}{r} l \cos \theta;$$

m and *l* occur on both sides of the equation, so may be cancelled. Then

$$H \sin \theta = \frac{2\pi C}{r} \cos \theta,$$

$$\therefore C = \frac{Hr}{2\pi} \tan \theta.$$

It will be noticed that this expression is independent of *m* and *l*, *i.e.*, of the magnetic moment of the magnet.

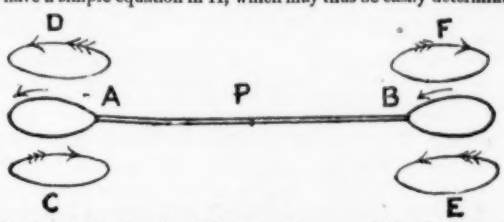
If now the value of H be known, *r* (the radius of the ring of wire) be measured, and θ (the angular deflection of the magnet) be noted, C is given in terms of known quantities, and its value may be accurately determined.

Of course if H be taken in C.G.S. units, C will be given in them also. To reduce it to ampères, we must multiply by 10.

Another interesting variation of this experiment may be performed. It is known that the ampère of current deposits in the second 0·000326 gram of copper from a solution of copper sulphate. If then a copper voltameter, consisting of two plates of copper immersed in a solution of copper sulphate, be joined in series with the tangent galvanometer and the cell furnishing the current, and the plate on which the copper is deposited be weighed before and after the current has passed for a time *t*,

$$C \text{ (in ampères)} = \frac{W_2 - W_1}{0{\cdot}000326 \times t},$$

where W_2 and W_1 are the weights after and before passing the current respectively. Then if θ be observed, and *r* measured as before, we have a simple equation in H, which may thus be easily determined.



Lord Kelvin's Ampère Balance consists essentially of a beam AB (Fig. 2) pivoted at P, with a horizontal coil of wire mounted at either end. These coils are themselves each placed between two other fixed coils, CD and EF, and the current to be measured is sent round the whole of these six coils in series, in the directions shown in Fig. 2, which is a perspective diagram, it being supposed that you are looking down on all the coils. It will be seen that the current in C tends to repel A upwards, and D tends to attract A in the same direction. Similarly B is pulled downwards by the action of the current in coils E and F. This pull can be neutralized by placing a weight on the arm AP, and the current is thus obtained independently of the field at the place. It will be noticed that since the same current flows through both the fixed and movable coils, the weight necessary to restore the beam to a horizontal position will vary as the square of the current.

Questions.

(1) A current is passed through a single coil of wire of a properly adjusted Tangent Galvanometer, and a deflection of 38° is noted. Assuming the Horizontal Component of the Earth's Magnetic Force to be ·18 dynes, find the current (1) in C.G.S. units, (2) in ampères, the radius of the coil being 10 cm.

(2) An electrical current was passed in series through a single coil tangent galvanometer and a copper voltameter for 30 minutes, and it was then found that the copper kathode had increased ·329 gram in weight. During the experiment the deflection of the suspended magnet was constant, and equalled 32°. What was the value of H at the place? Radius of coil = 10 cm.

(3) Explain fully why the attraction exerted by a magnet on a small piece of soft iron placed near it cannot be used to measure the strength of field at that place.

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Excelsior Greater Britain Atlas. New General Atlas of Modern Geography. Excelsior Freehand Drawing Cards: Common Objects, Series A—D. Excelsior Advanced Kindergarten Drawing Cards. Wall Picture: A Street Scene. London: Messrs. Bacon & Co.

'Greater Britain' is intended for scholars who are taking course A, Standard VI., Geography—the Colonies—and on the whole the maps are well adapted for the purpose intended. The General Atlas is a first-rate shillingsworth of mapping, and can be recommended as suitable for ordinary use in the case of all but the most exacting students. The index is full and correspondingly valuable.

Messrs. Bacon, more wise by far than the half-pay officers who control at South Kensington the directions in which the artistic yearnings of Young England shall go, have, from the first, insisted upon drawings requiring curves as well as straight lines, and have used these lines in the building up of the forms of common objects. Hence the present series is such as commends itself to the teacher who knows in what direction his children's cravings tend.

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Manual Training made serviceable to the School. By Dr. Woldemar Goetze.—**First Lesson in Hand and Eye Training for Boys and Girls.** By Gustav Kalb. London: C. Newmann and Co.

For this translation of this pair of technical instruction manuals we are indebted to Mr. W. G. Field, M.A., who has furthermore, with the consent of the author, added to and adapted for English wants the latter publication. So far as concerns Mr. Field the work has been well and truly Englished. The books themselves are deserving of serious consideration in these days of technical schools and advanced Kindergarten.

Dr. Goetze is almost as well-known in this country as is Herr Salamon, more than one child of his fertile brain and facile pen having obtained currency amongst us, and so long as he writes serviceable manuals of the same kidney as Manual Training we shall not feel constrained to cry Hold! Enough! for, sooth to say, the book is brimful of suggestions and directions calculated to benefit the neophyte and the past master in the gentle art of manual training.

The sections devoted to work are fourfold—A, Cardboard Work; B, Bench Work (Wood); C, Metal Work; D, Working in Glass. Each division is illustrated liberally with fairly good blocks, and directions of the most lucid kind are not wanting, whilst the unbeliever is not forgotten, seeing that the first two chapters are devoted to an explanation and illustration of 'How manual training may be made serviceable and possible.' The book is worthy of a wide popularity.

In these days of Suitable Occupations, Herr Kalb's book will be very welcome to many, since it professes to bridge over the gulf between technical work and the Kindergarten of the infant school, and, what is more to the point, goes a long way towards the full realisation of this profession. We heartily commend the volume to the many puzzled ones who are inwardly discussing the question, what shall we do to be saved in the matter of Suitable Occupations.

The Monarch Series of Uniform Memory Maps. Oldham: D. W. Bardsley.

For suitability and simplicity it will not be easy to excel the 'Monarch,' one speciality of which is the uniform and uniquely easy method of drawing the lines of latitude and longitude by simply bisecting the lines bounding the map. The only fault we find is that the shading of the coast line is in 'bilious green' instead of the orthodox blue—an objection which probably will not be shared by most of our readers.

Pitt Press Mathematical Series. Arithmetic for Schools, Part I. By Charles Smith, M.A. Cambridge: At the University Press.

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The Royal English Dictionary and Word Treasury. By Thomas T. Maclagan, M.A. London: T. Nelson & Sons.

This is not a mere abridgment or condensation of larger dictionaries. It is marked by several features which render it specially useful for young students, without increasing its size beyond that of the ordinary school dictionary. By a system of grouping derivative words and inflected forms with their primary forms, repetition is, to a considerable degree, avoided, and so space is economised.

The definitions are simple and clear; but the utility of the book is not confined to mere definition. Accent and pronunciation are indicated in accordance with a simple and satisfactory plan. The derivation of each word is also given briefly. But perhaps the most noteworthy characteristic of the work is the list of 'similar words,' or words almost synonymous, which are printed in italics at the end of every explanatory article to which such list can appropriately and serviceably be added. This will be particularly useful to the literary student engaged in composition, and seeking alternative expressions or the most fitting words for his purpose.

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We ought to add that many full-page and smaller illustrations suitably adorn the pages of the book, and most of them are very well executed.

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The Royal Crown Readers. First, Second, and Third Books. London: Thomas Nelson & Sons.

Of the many sets of reading books which have been issued by Messrs. Nelson under the general title of the *Royal School Series*, this we think, so far as may be judged from the first three numbers, must bear the palm for attractiveness. The binding is neat and substantial, the paper of excellent texture and surface, and the type of good size and remarkably clear. The readings include stories, anecdotes, and poems, all conveying in the most pleasing form lessons on duty and on nature, and nearly all marked by singular freshness. The usual helps to intelligence in the form of notes to explain meanings, with exercises on grammar and word-building, are given in abundance. But *the* feature of the volumes is the series of illustrations in colour-printing. These coloured illustrations we have never before seen equalled in any cheap publications. Their delicacy and refinement are simply charming, and the children who become familiar with them will be likely to acquire a genuine taste for artistic pictures. The illustrations in black and white are numerous and also tasteful in character. We feel justified in predicting that the series will become very popular.

There is one small point on which we would offer a word of remonstrance. Why do the compilers not add the names of the authors to the poetical pieces? This we think ought to be done at least in the case of the poems for recitation, of which a good selection is given at the end of each book.

The Young Crusoe. By Mrs. Hofland. Edited by Alfonzo Gardiner. London and Manchester: John Heywood.

This story, old-fashioned as it may be deemed now, will doubtless afford interest and instruction to many young readers in the new guise in which the editor and publisher present it. The biographical sketch and explanatory notes by Mr. Gardiner are brief and suitable. The illustrations, though not of a very high order, will add somewhat to the interest, and the unexceptionable moral of the story must have a good influence on its readers.

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Vere Foster's Bold Writing Charts for Class Teaching. The Principles of Penmanship as exhibited in Vere Foster's Bold Writing Copy Books. London: Blackie & Son, Limited.

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The Principles of Penmanship contains a description of Vere Foster's system of Bold Writing, with instructive remarks and a large number of models selected from the Copy Books.

The 'Cornhill Magazine,' February 1895. London: Smith, Elder & Co.

We have a peculiar pleasure in reviewing this issue of the *Cornhill*, as it is undoubtedly one of the best numbers published for a long time. One article in particular there is that is worthy of the highest commendation, its author being anonymous. 'Bringing down the House' is decidedly a cleverly-written piece of humour, and the reader whom it fails to amuse must indeed be phlegmatic; as a reading it would be immense. Among other of the contents we note an evidently well-written serial by Henry Leaton Merriman, entitled 'The Sowers.' The character note, 'The Peasant,' is well up to the usual standard, and on the whole the magazine is well worth sixpence.

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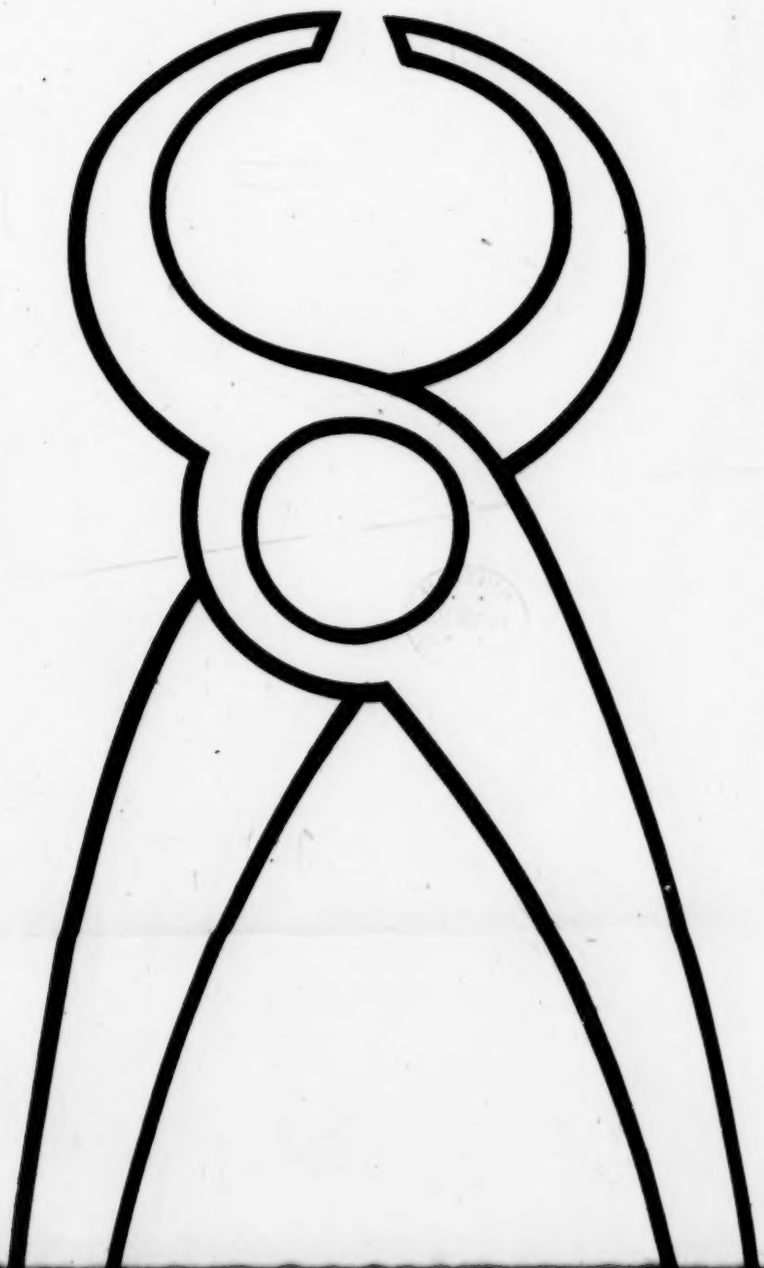

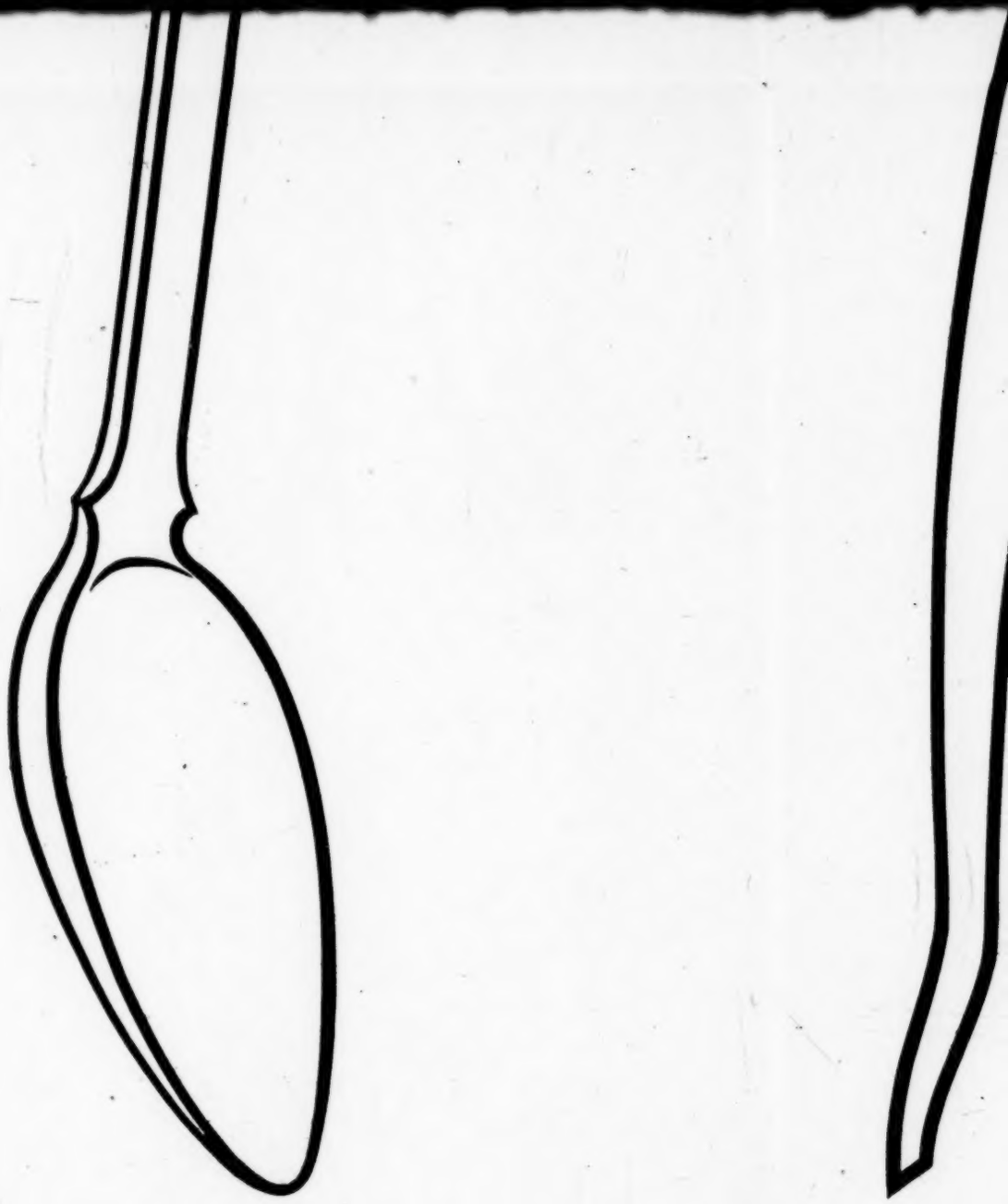

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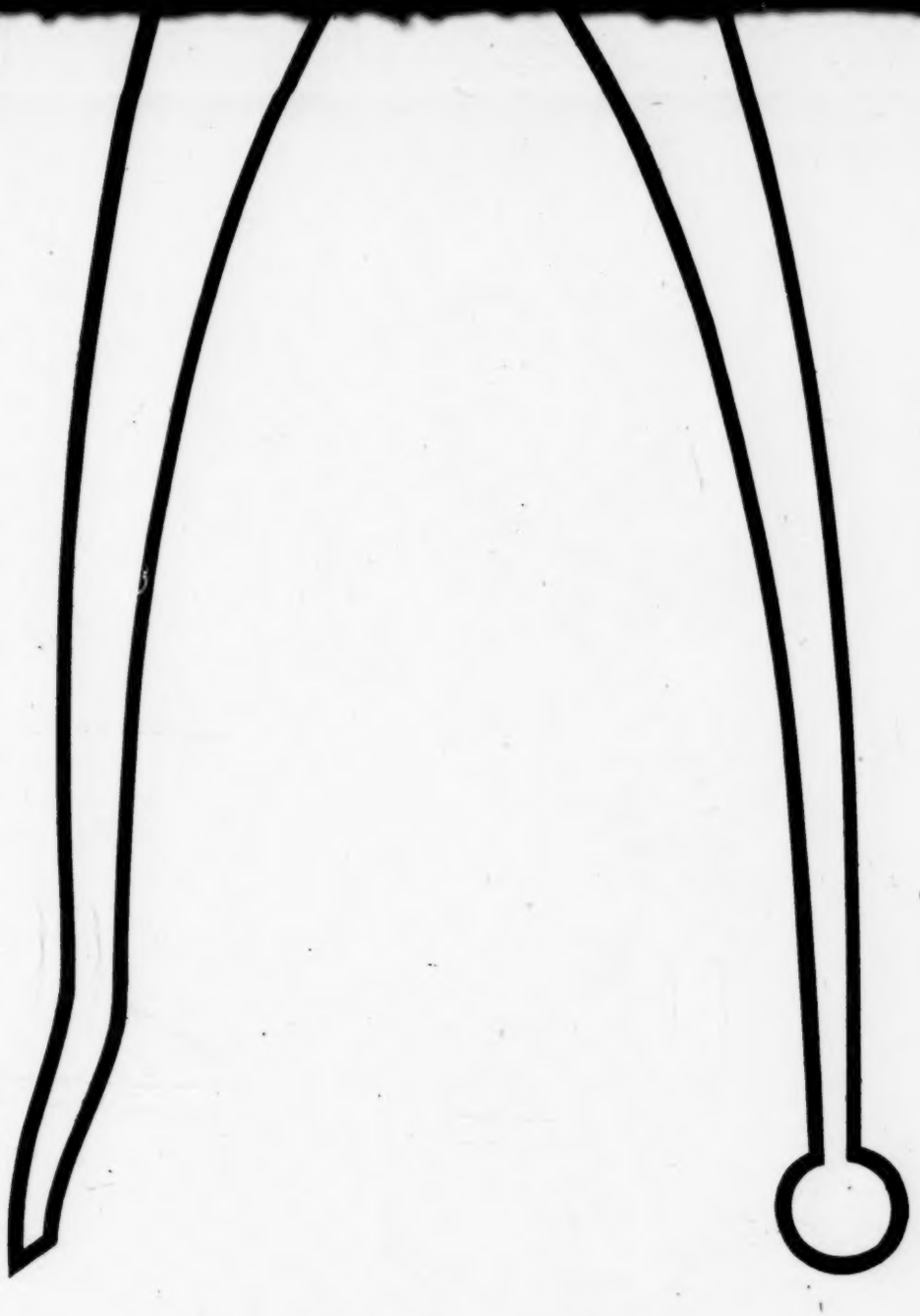

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THE LARGEST SCHOOL MUSIC PUBLISHERS

For fifty years the name of CURWEN has been associated with school music. The late John Curwen's earliest publications, in the forties, were publications of school music. From the first he placed good models, both in words and music, in the hands of teachers. We are accustomed to think of the first children's concert on the Handel Orchestra at the Crystal Palace in 1857 as representing the beginning of things, but the programme contained the names of Callcott, Cooke, and Spofforth, and included several German folk-songs of a high class. Other attempts of a worthy kind were, it is true, made to supply good music to the schools forty or fifty years ago. Dr. Hullah's own school songs are all pure in style; G. W. Martin's are equally tasteful. But it was the Curwen books that had the vogue, and they spread far and wide the singing of wholesome words and bright, tasteful music.

The firm of Curwen have moved with the growth of school music, and have led its advancement. Long years ago the late John Curwen engaged Mr. George Hogarth (the father-in-law of Charles Dickens) to edit a book of 'School Music' which he had selected. And in 1860 Curwen's 'Songs and Tunes for Education' placed within the reach of English Schools the best of the German children's songs, with Mr. J. S. Stallybrass's translations. In 1864 John Curwen tempted schools onward by issuing the first SCHOOL-CANTATA-OPERETTA—Root's *Flower Queen*. For many years this stood alone, but in 1880 it was followed by Broad's *Red Riding Hood's Rescue*, the first real CHILDREN'S OPERETTA, which has produced countless successors and imitators.

In 1872, when the ELEMENTARY EDUCATION ACT and the 'Music Fine' (happily long since abolished) gave a new impetus to school music, the firm brought out the 'Blackbird,' 'Linnet,' and 'Nightingale' series, which represented the then needs and capacities of the schools, have served their purpose well, and are still largely used in country schools. These books were issued in consultation with several thousand elementary teachers, who replied to the circular issued by the firm inquiring as to the sort of music needed for the schools.

In 1882—with some hesitation as to whether they were not going in advance of the times—the firm produced the 'GERMAN TWO-PART SONGS.' These represented a far higher point than had yet been reached. They demanded a cultivated musical taste, a feeling for music as an emotional language. The success of the series was immediate, and to this day it holds a commanding place in the school-music market.

About this time the growing attention paid to sight-singing and musical theory in schools caused the issue by the firm of many manuals of this kind, of NOTE AND EAR TESTS, of large CHARTS of exercises, of HANDBOOKS FOR TEACHERS, of SPECIMEN LESSONS.

The needs of the TRAINING COLLEGES were not forgotten. Condensed and well-written text-books and exercises were supplied for them, in the important work of training the future teachers of singing in schools. Books for PUPIL TEACHERS were also brought out in great variety; small, handy, cheap.

The increased study of the STAFF NOTATION was anticipated and encouraged by the issue of large Staff Notation Charts for the Schoolroom wall or easel, and by the provision of cheap song books in the staff notation.

The special needs of INFANT DEPARTMENTS were remembered. Books of little songs, simple and transparent in diction and thought, easy in melodic construction, were published in rapid succession. The demand for Infants' Action Songs was met by the production of many books of this class, the songs covering all possible subjects of interest to the little folk. As Froebel principles spread in the Infant Schools, KINDERGARTEN GAMES were added.

In 1888 the success of Mr. A. L. Cowley's CONCERT ACTION SONG 'The Japanese Fan' (which still maintains its extraordinary popularity) led to a new departure. The firm began to provide at a rapid rate a series of dramatic songs for children of the standards to sing to their friends at school concerts. Every possible personation is now provided, every form of humorous incident, every trade and occupation is travestied or imitated.

As the ORCHESTRA began to find a place at school concerts, the firm provided orchestral parts of their school operettas and for some of their school choruses. The supply of school songs in instrumental form, such as Vocal Waltzes, Vocal Marches, followed.

The need of something more developed than the primitive school song led into the starting of 'CHORUSES FOR EQUAL VOICES,' the most varied and comprehensive supply of school music to be had. Here, generally with pianoforte accompaniment, are descriptive choruses and part-songs, anthems, carols, rounds, dance forms, all composed or arranged for children's voices, and including the names of MENDELSSOHN, HANDEL, RUBINSTEIN, STERNDALE BENNETT, MOZART, HENRY SMART, VINCENT NOVELLO, WAGNER, BALFE, VINCENT WALLACE, and many others.

Recognising the growing feeling of the need for teaching young Britain to love the Flag and grasp the idea of the Empire, the firm have issued a special list of music with PATRIOTISM for its subject, and several eminent statesmen and members of Parliament have expressed their approval of Messrs. Curwen's action.

The most distinctively national form of our English part-music is the GLEE, and the firm, quick to recognise this, led the way in the issue of the best works of Bishop, Callcott, Horsley, Cooke, Webbe, Stevens, and Mornington, arranged for equal voices. They are following these with some equal-voice arrangements of sixteenth century Madrigals, which will tempt the senior departments to the delights of CONTRAPUNTAL MUSIC.

The strongly expressed opinion of several musical leaders is that schools should study the FOLK SONGS of their own nationality. Of the four nationalities in the United Kingdom, England has been the worst provided in this respect, not because she has no folk-songs, but because they have not been accessible in suitable form for schools. This was the origin of the 'Folk Songs of England,' brought out by the firm in January, 1892, a publication which has received the warm praise of Prof. Stanford, of Cambridge University.

Most largely circulated of all Messrs. Curwens' school publications are their 'SCHOOL MUSIC LEAFLETS,' which scatter themselves by hundreds of thousands in all the schools of the land. In this series a good school song is given on a single leaf of paper, staff notation on one side and Sol-fa on the other, and each department or music division can select its own songs for the year, fastening half-a-dozen of these Leaflets together with a metal clip or a thread. When the children have learned the song from Sol-fa notation they can turn the leaf, and by trying to sing it from the staff will soon become familiar with their crotchets and quavers.

Whole operas, like *Maritana* and *Bohemian Girl*, are now being issued, arranged for school use.

In choosing school music for publication the advisers of the firm have in mind the fact that it is not enough that school music should be correct and unexceptionable. To attract children and fulfil its mission in brightening the schoolroom it must be interesting both in melody and words, it must have positive qualities, must strike the ear and the fancy. Fun and humour, so long as they are refined and wholesome, are to be encouraged in school songs; there must be lighter as well as more solid elements in the musical feast. At the same time the words must be such as will stand by themselves, and pass as literature; they must also be within the comprehension of children, and suitable for them to utter. These principles of selection have guided the firm for fifty years, and have given a world-wide circulation to the SCHOOL MUSIC OF J. CURWEN & SONS.

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